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THE NATIONAL GEOGRAPHIC MAGAZINE

Because It Rains on Hawaii

By Frederick Simpich, Jr.

THE NATION starts talking when any Territory asks to join the Union as a new State. A candidate for statehood gets the same scrutiny as a would-be son-in-law might get from a girl's family.

That's how mainland Americans are looking now at Hawaii, talked of in Congress as our 49th State. If admitted, it would be the first member of the Union not a part of continental United States.

Hawaii, lying out in the warm Pacific some 2,400 miles southwest of California, is an island group long ruled by a native royal family. Liliuokalani was the last queen. After a "revolution" the islands, by treaty, were annexed to the United States in 1898.

Though the seven seas are laced by colorful archipelagoes, Americans feel there is no other group of islands quite like Hawaii. Mark Twain called them "the loveliest fleet of islands that lie anchored in any ocean" (map, page 575).

Hawaii Grows Fat on Water

The Hawaiian group *is* unique. It has no natural resources—but plenty of rain!

This rain makes Hawaiian sugar so luxuriant that it can serve the sweet tooth of some 20,000,000 Americans. Rain, transformed into Hawaiian pineapple, supplies most of the United States. And flowers and scenery, nourished by tropic rains, lure an enthusiastic tourist trade (page 596).

In this water-minded fairyland cattle swim part way to market, herded by seagoing cowboys. I know one plantation that tunneled around a volcano to move water 30 miles. Another pumps enough underground water to supply a big city.

To get the rain where it counts most, planters construct sprinkler systems, giant versions of the one in the city dweller's front yard, so big that one nozzle sends a spray over three acres.

Hawaii's dependence on water is complete. Virtually everything it eats and uses comes by water.

Islanders are never more conscious of the Pacific reaches around them than during longshore strikes. As this is written, labor troubles in both Hawaiian and mainland ports have cut off overseas supplies and markets for more than seven of the twelve months past. Such times highlight Hawaii's dependence on waterborne commerce.

Normally her supply lines run on ferryboat schedules. There are Tuesday freighters from San Francisco, and on Thursdays the Los Angeles ships come in. Every ten days brings a vessel from the east coast and Gulf ports and another fortnightly from the Pacific Northwest, supplemented by freighters handling lumber from the same region. These regular sailings operated by the Matson and Isthmian Lines are fattened by frequent calls of trans-Pacific steamers seeking bunkers and stores or discharging and loading way freight.

Foreign Flags Now Scarce

Prewar demands of the Orient-born population brought many bizarre house flags into Honolulu Harbor. Since V-J Day, with the great NYK fleet of the Japanese sunk and Dutch, Swedish, and British fleets still rebuilding, foreign flags are scarce. Rebirth of Hawaiian commerce abroad is also curbed by dollar restrictions, Australian austerity, civil war in China, and General MacArthur's limitations on foreign trade with Japan.

But the commerce remaining with the mainland United States has always bulked large. Hawaii now buys more from the 48 States

William Lovd from Three Lions

School Lets Out; a Library Silence Extinguishes Yells and Screams of Play

The islands' first pupils were adults who learned their letters from a Hawaiian speller devised by missionaries in the 1820's. These children, product of many races, speak English as their heritage (page 595). Their school system compares favorably with the mainland's. The bookmobile visits Oahu's rural schools twice a week.

Hawaiian Pineapple Company

From Endless Belt to Shiny Can, Peeled Pineapple Is Never Touched by Bare Hands

Automatic machinery trims off outer shells, punches out cores, and cuts slices, but judgment counts at the packing table. These women grade the fruit as they fill the cans. With syrup added, the product will be sealed, steam-cooked, and labeled. The entire process at this Oahu cannery takes 15 minutes (page 600).

than did Cuba or China, Belgium or France in days of prewar prosperity.

Mainland-bound ships carry sugar, pineapple, and tuna fish.

Big item for a time has been surplus war goods. The War Assets Administration has sold more than a quarter of a billion dollars' worth of surplus in Hawaii since V-J Day.

These rolls of barbed wire, bulldozers, jeeps, and generators have found use from California farms to eastern cities. Scrap steel, more than 50,000 tons of it, has been returned for mainland furnaces. One enterpriser tried to tow the U.S.S. *Oklahoma*, a victim of the Pearl Harbor attack, back as scrap, but she sank some 540 miles off the island of Oahu.

Inbound cargoes make up all the things men live by, from razor blades to fuel oil, chain conveyors to dairy feed.

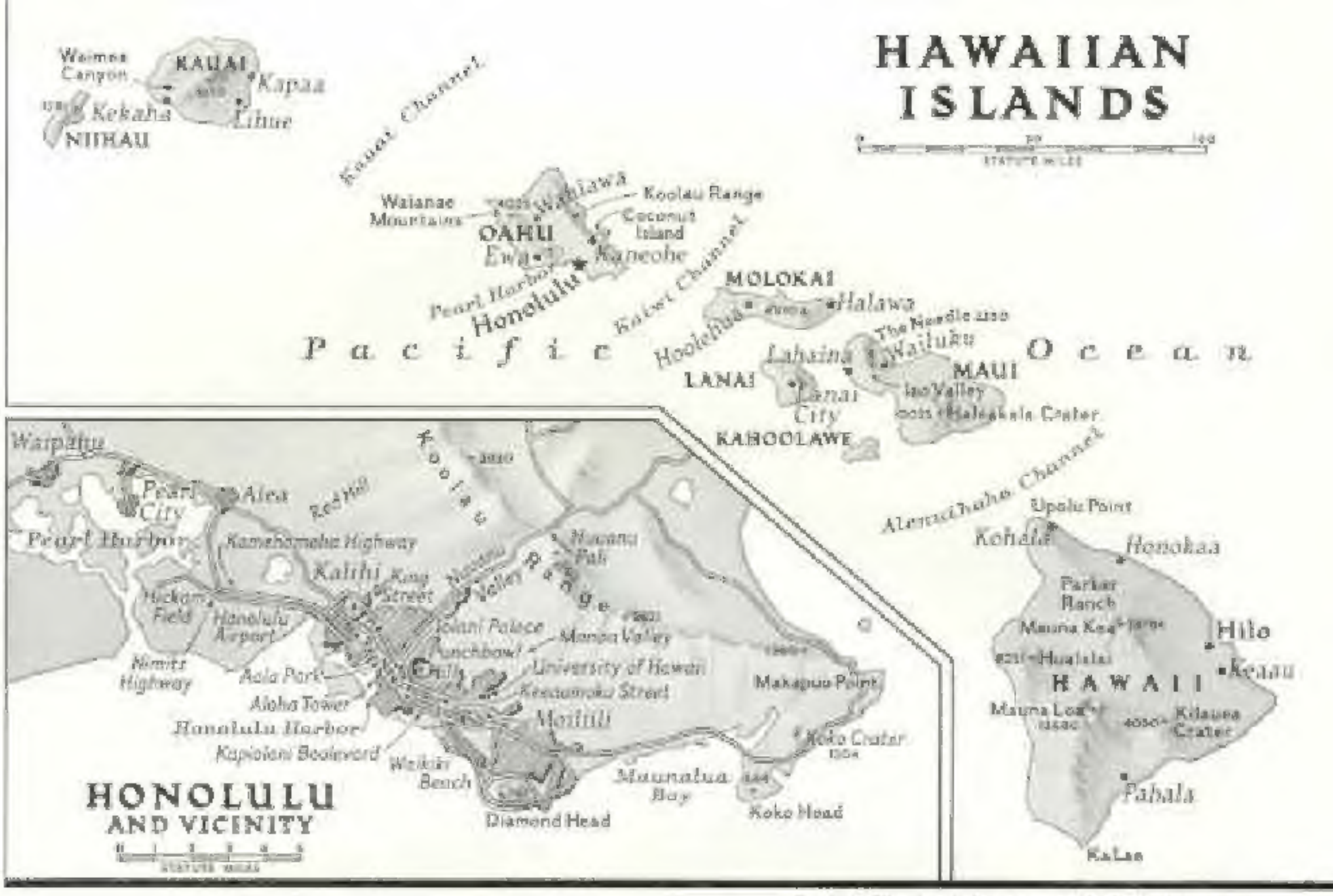
In Hawaii only the climate and the scenery are native. The Hawaiians themselves are immigrants. The decks of their double canoes brought the first domestic animals and much plant life. The sugar cane and pineapple grown now were transplanted from other tropical lands.

This elaboration on Nature is unending as men work to make Hawaii a better place to live. Roads are laid with Bitumuls from California. Reservoirs are built of Pittsburgh

Photo: Hassell

A Tuna Sampan Fishes with Barbless Hooks, Free-swimming Bait, and Manufactured Foam

Japanese Americans, barefoot on a dippery, railless deck, fill the well with 15-pounders. Lunging at live bait cast into the sea, the tuna snatch at shiny hooks as readily as they do at flashing chum. Nozzles (note the spray) squirt water from the sampan's sides to imitate the froth of escaping prey (pages 596, 602).



Drawn by Theodore F. Thompson and Irvin E. Altman

Hawaii, of New Jersey Size and New Hampshire Population, Wants To Be the 49th State

Eight main islands, stretching across 400 miles of Pacific, produce virtually all of our canned pineapple and one-quarter of our sugar. Each represents a peak thrust up out of the ocean by internal fires. Hawaii Island, where two live volcanoes spout lava, is still growing. Inset shows the Honolulu area on Oahu.

steel and California cement. The Territorial Department of Agriculture stocks streams with fish from Oregon. The Hui Manu, a women's organization, imports and frees colorful birds to brighten island gardens. Undeterred by strikes, they recently booked air freight, brought in crateloads of rainbow-colored buntings from Mexico for propagation.

Mayonnaise by the Ton

Walk the Honolulu docks after any freighter arrival and you are staggered by the intricate demands of modern life as pictured there. Mayonnaise by the ton; mountains of cigarettes; beer by the thousand caseloads; hospital-white refrigerators standing in precise rows; and mattresses, auto tires, table china, clay pipe, dynamite, herbicides, nitrates, and floor lamps.

Search the room where you read. If you lived in Hawaii, everything you see would have come by ship.

Careful use of water, among other factors, has made the limited land of the islands produce more calories to the acre than any other in the world.

From an area less than that of New York City, Hawaii grows 25 percent of all sugar produced under our flag (pages 577, 592, 593, 597). Such yields support half a million people in the American way of juke boxes and traffic jams. Two centuries ago, half as many natives warred and practiced infanticide because this same land was not enough—by primitive methods.

To achieve such land use, the Yankees who engineered it imported everything but water. Labor was recruited from China and Scandinavia, Japan and Madeira, Puerto Rico and Portugal, Philippines and Indiana. From India and New Guinea, Louisiana and Barbados came sugar cane from which to breed new strains. Cayenne pineapple was borrowed from Jamaica (pages 588 and 600). Fertilizers were called forward from Chile, Canada, and the guano islands.

A Mid-Pacific Melting Pot

Thus grew cosmopolitan Hawaii. In my short time here I have seen its population, now 540,500, grow to exceed that of six States. Biggest elements are the 179,000 Japanese Americans, followed by 175,000 Caucasians and 82,000 Hawaiians and part Hawaiians. Filipino, Chinese, and other extractions fill up the rest of the "melting pot of the Pacific." Virtually all are U. S. citizens (pages 572, 579).

The first people to come were Polynesians, possibly a thousand years before Columbus

Punchbowl, Once a Pit of Fire, Is Now the Green Abode of War Dead

Though it was rough and barren, this extinct volcano attracted many visitors in former years because its 500-foot wall commanded a glorious view of Honolulu and the sea (page 605). Today there is more reason than ever to visit Punchbowl, for its oval has been smoothed and greened and dedicated as the new National Memorial Cemetery of the Pacific.

This monument appropriately looks out upon Pearl Harbor, the naval base (not shown), where America entered World War II on December 7, 1941. The first American lowered into a grave here was an unknown serviceman killed by the Japanese attack.

Others came from battlefields in Guadalcanal, China, Burma, Saipan, Guam, Iwo Jima, and the prison camps of Japan. Many were Hawaii's own sons; some came from other theaters of war.

Eventually the 35-acre burial area will be filled with 25,000 graves, approximately 13,000 of which will be World War II dead; the remainder will be veterans of all wars.

Soldiers, sailors, and marines are laid side by side, with no distinction as to rank. Each grave will be marked with a simple headstone.

Hawaii Visitors Bureau

Cane's Portable Ditch Is Taken Apart Only at Planting Time

Sugar cane, which is a grass, requires heat, rich soil, plenty of water, and diligent care. The Hawaiian Islands have no lack of sun or soil, but half the area must be watered artificially, and labor, represented by this full-time irrigator, has become expensive.

To get water and save manpower, the big plantations have invested millions in dams, wells, and machinery, and these have paid off handsomely. Scientific methods have doubled and sometimes redoubled the yield.

This Oahu plantation, for example, has an irrigation flume made up of hundreds of concrete links, each a furrow wide. Metal slides in each unit control the escape of water.

For close to two years the field will be watered at intervals of 15 to 20 days. Then it will be dried for a month, the trash burned off, and the cane cut. The flume is disassembled when the cane is again planted.

Here the field has been freshly planted with sugar cane's bamboolike joints, which, like potatoes, contain sprouting eyes. A machine has dug the furrows, dropped the joints, and applied fertilizer in a single operation.

Such a planting will suffice four to eight years. When the cane is cut, eyes below ground sprout and send up new stalks (pages 592, 594, and 597).

Photo: Hawaii

showed the egg to Isabella. They and successive Polynesian immigrants became the "native" Hawaiians discovered by Capt. James Cook in 1778. Forty-two years later New England missionaries arrived to form the first stable white colony.*

These God-fearing evangels laid the groundwork for modern Hawaii. They and their descendants built her churches, arts, and business; helped lead the revolution which overthrew the native monarchy in 1893; and influenced annexation by the United States in 1898. Today their descendants call visitors to play tennis or talk business.

Eight principal islands make up the Hawaiian group. Lying south of the Tropic of Cancer on about the same parallel with Mexico City and Hong Kong, they are five time zones behind New York. All volcanic, they angle 400 miles from northwest to southeast.

First is Niihau. Next is Kauai, with the highest annual rainfall on record (some 600 inches in late months) for any station in Hawaii. Third is Oahu, site of Honolulu and Pearl Harbor. Then comes Molokai, noted for its leper colony, now dwindling; next, Maui, Lanai, and barren Kahoolawe. This last is used only as a Navy bombing range.

At the extreme southeast is the island of Hawaii, which is still growing. Here two live volcanoes, Mauna Loa (page 604) and Kilauea, erupt with regularity and spill lava seaward to build land which may some day become a fertile plain.

Even blasé old islanders throng to Hilo when the volcanoes "go off," and proudly boast that Hawaii is the only place where people run to an eruption (map, page 575).

Honolulu, playland capital of Hawaii, is two cities. In one, more than a quarter of a million people pack pineapple, drive buses, attend church—but seldom ride a surfboard. In the other, sun-seeking tourists, shiny with coconut oil against sunburn, throng the beaches and tropic-style night clubs to nourish the island's third largest business, to the tune of about $33,000,000 in 1948.

As if dramatizing Hawaii's dependence on water, Honolulu hugs the sea. For 17 miles, from Pearl Harbor to the extinct crater at Koko Head, it pushes against the Pacific, rarely venturing up the ridges of the Koolau Range at its back.

The main streets of this long, thin city tell its story.

Every morning half of Honolulu rides to work along Kamehameha Highway, named for a native conqueror. Nimitz Highway, named for a later one, also runs in from Pearl Harbor to the city's center. These avenues to the industrial district pass acres of Government housing for defense workers, Honolulu Airport, and the Air Force's Hickam Field, where B-17's took off one day to help make history at Midway.

Honolulu Harbor Pivot Point

The city's pivot point is Honolulu Harbor. Here, amid fertilizer works, fuel storage tanks, lumber yards, and bottlers of soda pop is the plant of the Hawaiian Pineapple Company, Ltd. (Dole), largest fruit cannery in the world. Every visitor remembers its giant pineapple that serves as a water tower.

King Street passes near the harbor and carries on to Honolulu's Hyde Park, called Ala, where politicians draw crowds with hula troupes and hold them by singing "Three Blind Mice" in Hawaiian. Adjoining slum alleys mark this a seaport town and recall the roaring fifties when annual visits of the whaling fleet meant riot and rapine.

The city's shopping district was once distinctly Oriental, and goods are still offered in the wild profusion of Eastern bazaars. The shopper finds *tabi* (the glovelike Japanese socks) mixed up with nylons. Ivory back scratchers share the same shelf with electric blankets. King Street saloons sell *saimin* and *sake*, steak and Scotch.

Abruptly the visitor enters the modern downtown district of smart shops, department stores, solid-looking banks, and "factors," management firms that run the sugar plantations and much of Hawaii's basic industry.

Here too are the Government buildings, grouped around the Territorial Capitol, Iolani Palace, one-time home of Hawaiian kings. These lovable south seas sovereigns copied European monarchs even to their vanity. The Capitol Building's promenades are still lined with small mirrors—just face high!

From mid-town, Kapiolani Boulevard carries on toward Waikiki over land which my father remembers as swamp, good only to raise bananas and ducks. How odd that men have labored to reclaim it for secondhand dealers to hawk jalopies!

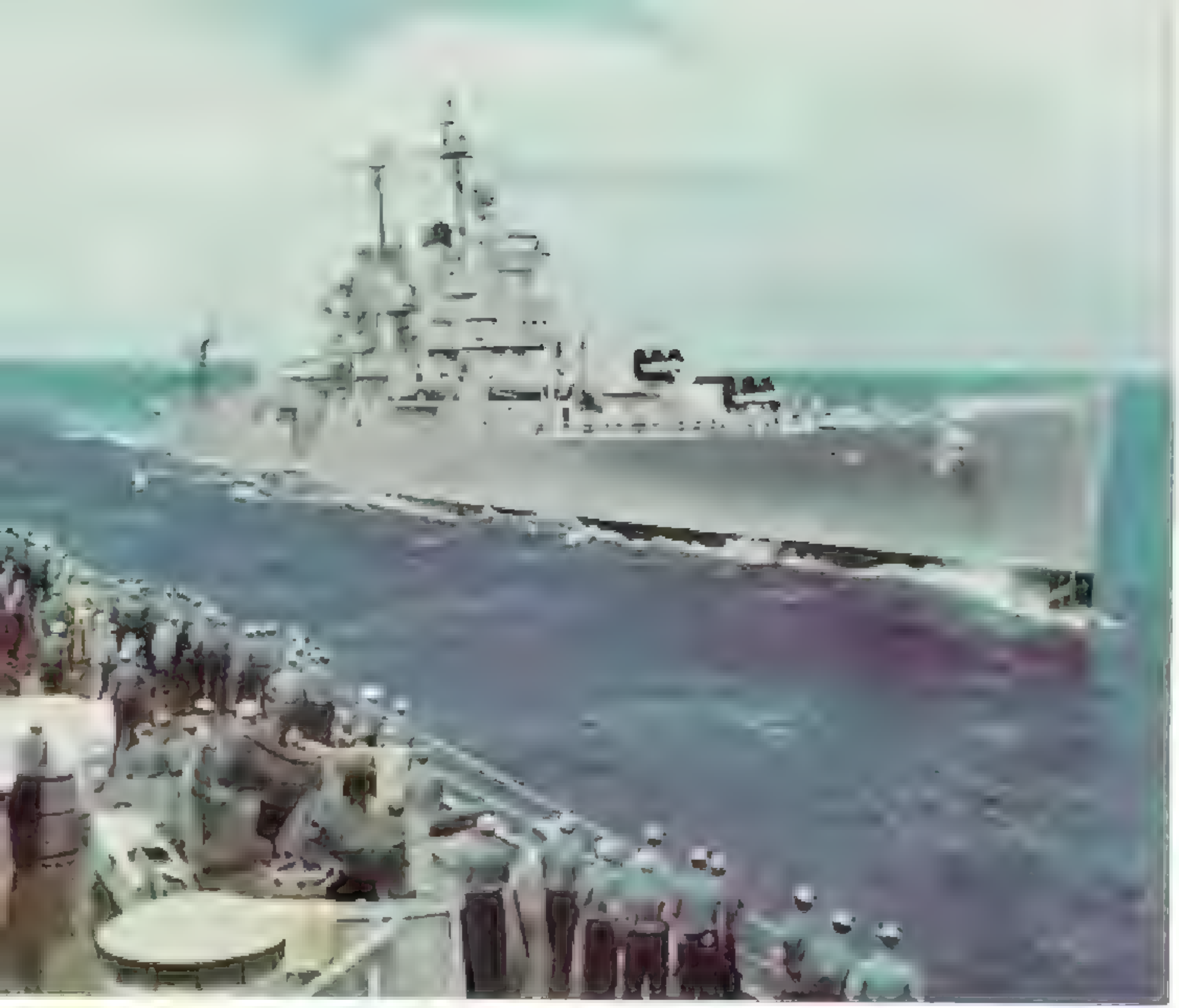
Waikiki is bare midriffs and apartment houses, sandy feet and "drive-ins."

Here stenographers and maharajas jostle for sunning space on a narrow beach, and here the amphibious, buoyed by surfboards, spend full days in the water (pages 584, 585, 594, and 598).

* See, in the National Geographic Magazine: "Hawaii, Then and Now," by William R. Castle, October, 1938; "Hawaiian Islands," by Gilbert Grosvenor, February, 1924; and "American Pathfinders in the Pacific," by William H. Nicholas, May, 1946.

A Carefree Flower of the Pacific Garlands Hair with Hibiscus and Neck with Lei of Plumeria

It's summer all the year in Hawaii, and people dress for it. Few homes have central heating systems. Because of extensive immigration, native Polynesian blood mingles with Oriental and Caucasian. Few pure Hawaiians are left.



Light Cruiser *Pensacola*, Crossing to Pearl Harbor, Carries Marines Aboard To Take On Fuel

Dean Sharpe's Successor, Midshipman Stand to Attention Below the *Essex*'s Guns

Dramatic Contrasts: Pacific's New Streamlined Cruise Liner, California, Moho Tower, Where Dignitaries Welcomed Visitors

Honolulu Says "Aloha" with Flowers and Greetings. Hawaiian Beauties Garland Visitors with Leis. Polynesia's Bright Necklaces

Whispering Breezes, Rustling Palms, and Murmuring Sea Sing Waikiki's Lullaby — Exhilarating Water Times Bathers and Surfboarders

Bass Rock, Tantallon Castle, and Slains Castle from Shore at the Outriggers Boat Begins on Wemyss Beach

Helped King Kamehameha I, Hawaii's Noblest Hero, Is Smothered in Lei

Dressed as Royal Robes, Honolulu Celebrates Each June 11 as King Kamehameha Day

Pineapple's Monster Harvester Reigns on Hawaii Fields

Oahu Grows These Bird of Paradise Flowers for Export to the Mainland (Page 603)

A Japanese American Admires Her Family's Field

A Breathtaking Mass of Cumulus and Cloud Shadows Bursts into View from the Pale Horseshoe's Lunar Observation Point

[illegible]

Jocelyn Hale Gives Dance in Tableau Scene. Gesture Is Lost in Demure Shetland. Carving Horses Depict the Moon

Sugar Cane's Production
Can Have 50 Times as
30 Times as Have

Cars's Silvery Tassels Shine in Beauty but Make No Sugar

Figure 5: [illegible] Clouds [illegible] Third Industry Is Recreation

Each stretch of surf has its own character. There are "Queen's Surf" and "King's Surf," once reserved for royalty, and, if wind and wave are right, "Steamer Lane" for the intrepid. From the farthermost rollers, a full mile out, a good surfer can ride all the way to shore and a rewarding bite of the beach-boy's delicacy—dried squid.*

Here my young son learned to ride in on his board—and how he misses it now, back at school in Massachusetts!

Diamond Head, beyond Waikiki, is Hawaii's tourist trade-mark. Fringed by wealthy homes such as Doris Duke's little-used "Shangri La," this aging cinder cone is pocked by strong points, vestiges of a military age when shell fire won wars (page 605).

Exotic Flowers in Every Back Yard

For each home with a view of the sea Honolulu has a thousand that look out on the neighbor's wash. Clustered about shopping districts with tongue-twisting names like Moiliili and Kaahi, each has its garden, with at least one of the 4,000 varieties of Hawaiian hibiscus. This shrub is so common now that gardeners name new strains after friends.

Many of the exotics—anthurium, orchids, gardenias, *ape*, and ginger—grow here if watered (pages 580, 603).

Scattered among the homes are Honolulu's institutions. In Manoa Valley, where early settlers built New England-style houses under an ever-present rainbow, the University of Hawaii now teaches more than 4,000 students, among them many ex-GIs, to become sugar planters and schoolteachers, industrial relations men, and veterinarians.

Cultural centers include the Honolulu Academy of Arts where Kwan Yins and Picassos vie for admiration in this cosmopolitan city. At the Bishop Museum is the world's best collection of Polynesiana—nose flutes and ornaments, fishhooks of bone, and full-length cloaks built from feathers of the o-o bird.

Games fascinate Honolulu. High school football draws sell-out crowds of 25,000. There are more than 200 pool halls, by latest count—one for every 1,500 people.

Leading U. S. swimmers, such as Duke Kahanamoku and 400-meter Olympic champion Bill Smith, paddled first in the thundering surf of Waikiki (page 608) and reached competitive perfection in the 100-meter pool of the World War I memorial at Waikiki.

No island boy has missed the pleasure of one old Hawaiian sport, ti leaf sliding. Equipment is the same for rich or poor: a bundle of these big leaves as a sled, a steep, muddy bank on a mountainside, a tolerant mother, and a pair of old trousers.

Few other cities offer so many extra days off as Honolulu. Rizal Day for the Filipinos, Kamehameha Day for the Hawaiians (pages 586, 587), Boy Day for the Japanese, and Chinese New Years only begin the list. I help celebrate the other fellow's holiday by watching him parade.

Most colorful parade is the Hawaiian, with its men in breechclouts and feathered helmets, its bearers of *kahili* (standards now made of flowers instead of feathers), and its gaily gowned horsewomen called *paia* riders. Japanese lantern parades have been resumed since the war, and on Boy Day each Japanese-American home lucky enough to have sons heralds its pride by flying giant pennants cut and painted to represent a carp, the fish symbol of fearless courage.

Imagine traffic having to stop to let a dragon go by!

Old-style Chinese funerals, with white-clad professional mourners and papier-mâché monsters disrupt traffic. For days after, streets are littered with perforated serpentine scattered by the procession so that evil spirits—which must find their way through each little hole—will never reach the grave.

Boat Days Always Festive Occasions

Boats mean much to these islands—mail, food, recreation—even that long-awaited new orchid. Traditionally, boat day in Honolulu draws a crowd. Whenever Matson lines berth, thousands gather below Aloha Tower to join the Royal Hawaiian Band in a musical welcome (page 582). When they sail, an even greater crowd gathers to sing *Aloha Oe*, without a dry eye on dock or deck.

People here adopt one another's customs and confusion sometimes results, as with shoes. A young Nisei (second-generation Japanese American) matron entering her prefab home leaves her Hollywood wedgies on the doorstep from a traditional desire to keep floors clean. Sears Roebuck's new store boasts an escalator pulled now to see that children, invariably barefoot, don't pinch toes. Island boys of all races play fine football, yet kick better barefoot!

English is the language, but apt words have been freely borrowed from many tongues. Such include the Hawaiian *kaaka* for "foot," and the Chinese *hui* for "partners."

Simplified English words and phrases serve instead of the pidgin of tropic islands farther

* See, in the NATIONAL GEOGRAPHIC MAGAZINE, "Waves and Thrills at Waikiki," 8 illustrations in duotone by Thomas Edward Boke, May, 1933.

When a Tuna Crew Is Not Fishing, It Is Eating; 5 Meals in 18 Hours Is Modest Fare

[illegible]

[illegible] "Hawaii [illegible] Honolulu [illegible] Hole."

"Good [illegible] backwards produce new slang. When Hawaii [illegible] American [illegible] one of the most [illegible] in America [illegible] History during World War II so far as [illegible] [illegible] Hawaii [illegible] [illegible] Kokua [illegible] Lanai [illegible] Japanese [illegible] Wi-[illegible] [illegible] Hawaii [illegible] [illegible] The [illegible] in low crime and [illegible] [illegible] standards of public [illegible]

[illegible] visitors when [illegible] Combined with [illegible] transportation [illegible] [illegible] [illegible]

The War Reversed Travel Habits

But the war reversed [illegible] [illegible] Mainland [illegible] Hawaii. [illegible] Northwest [illegible] [illegible] [illegible] compete with [illegible] [illegible] [illegible]

As [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

or guitars are often carried, and "coconut" huts woven from palm fronds are a fad with teen-agers. Crazy tourists display all three at once.

Pity the "midnight sun" who comes to Hawaii expecting another Miami or Las Vegas. The gambling ban, midnight closing, and moderate tempo favor rest and romance, not racing and red dog—which pleases us who work here for a living.

Hawaii is a place for record-size marlin, golf by the sea, scenic rides, and sulphur baths drawn from the steam of live volcanoes. It [illegible] and *lomi-lomi* salmon (raw salmon), Bombay duck and *kalimachi*. It is a place to tan by day under a brilliant sun and sleep by night under a blanket. It is a place to dance as the trade winds blow the big South Sea moon up from behind Diamond Head and across the star-studded skies toward the Waianae Mountains. But here are no "pistol-packing mammas," no chuck-a-luck, no late-spot [illegible]

Tourist Lure Is the Weather

Principal tourist lure is the weather. Seasons are not perceptible, daily temperature [illegible] rainbows [illegible] "April showers." But great rainpours can flood streets and lawns, force tourists indoors to bridge and movies.

Much small business, particularly on outer islands, centers about the tourist trade.

To move among the islands, one may choose between weekly cattle boats or one of 60 to 70 PAA-3 flights each day. Often more than a thousand people fly to other islands between dawn and dusk. Machinery, stoves, furniture, and hardware move out from Honolulu by air; vegetables come back.

On one regular business trip I fly past four islands to reach a fifth. Often the sea and shore are obscured, but towering mountains break through the cloud to appear as lesser islands in a sea of scud.

Many curios are island-made, though ukuleles are from Pennsylvania and hula skirts come from New Jersey!

Local products include safely grained bowls tooled from iron-hard koa wood, necklaces of flower blossoms fashioned from ivory, and such sweets as mango chutney and guava jelly. There is a big trade in sports clothes. Once-fashionable "Musa-Shiya, the Shirtmaker," has forsaken custom work for assembly-line production of swim shorts.

Where under the American flag but in Hawaii could anyone sell such heterogeneous wares as throw rugs, a pasty food made from taro root, rice cakes lined with fish skin, service as a letter writer for illiterate Filipinos, and four-color photographs of Sun Yat-sen?

Desperately the islands seek a third money crop to supplement sugar and pineapple. I've done such scouting myself. Sisal, peanuts, potatoes, asparagus, and macadamia nuts have been tried, grow well, but lack commercial importance. Land, labor, and water are better used by cane and "pines."

Sugar—Big Business in Hawaii

Sugar is big business.

Nobody knows how cane first came here. Captain Cook found it growing as a hedge around native huts, introduced by birds or even washed ashore. Hawaiian legend tells of a Chinese junk blown off course and shipwrecked here. If so, sugar may be the legacy it left.

Production has been on a plantation scale since 1843. But the sorry stalks of a century ago were weeds beside the stands that today trace more than 200,000 acres of Hawaiian coast line. This sturdy, towering cane is the product of 50 years of research. By untiring crossbreeding, producing 500,000 new varieties a year, these qualities have been gained: It is rich in juice; has few profitless leaves [illegible] in" fast to reduce weeds; is secure from plant disease; and resists drought (pages 592, 593).

To see how Hawaiian planters do it, plant geneticists from Java and India, Florida [illegible] the West Indies come to visit the [illegible] experiment station on Honolulu's Kecaumuku Street.

Sugar scientists fight bugs too. They have saved the Hawaiian industry from pests by searching and finding, in far corners of the earth, parasites that prey on the destroyers. A late importation (1932) was a hundred-odd toads, *Bufo marinus*, originally from South America. They multiply like rabbits and, like goats, eat everything from cigar butts to paper napkins. These bufos, a multitude now and spread to all islands, have won housewives' favor, too, with their taste for centipedes and scorpions.

A pound of sugar needs about two tons of water to grow on. Producing a quarter of the cane and beet sugar grown under the U. S. flag, Hawaiian business has invested more than $40,000,000 in irrigation alone, probably the biggest privately financed irrigation project under our flag.

Battling always to save water, planters court new ideas. Seepage-proof concrete and aluminum sections of movable flume now replace dirt ditches (page 577).

W. J. Hall, hydraulic engineer, spotting a

A Waikiki Outrigger Rides a Breaker with the Effortless Ease of a Toboggan Hurtling Down an Icy Slope

Principles: Earth's Scents a Guide's Info Detecting at the Soil

[illegible]

NATIONAL GEOGRAPHIC MAGAZINE illustration of overhead irrigation as used on Costa Rican banana,* caught a plane for United Fruit Company's Boston headquarters and received permission to buy some of its nozzles and make extensive tests with them in Hawaii.

Plantations in rainy belts need no irrigation. Some of them float cut cane to mills down steep wooden troughs. It's great sport to ride a bundle of this cane as a raft, pell-mell down a mountainside (page 610). Old-timers tell of a wooden legged manager who customarily got around his fields on horseback; then, at quitting time, unstrapped his leg, threw it into such a trough, and, hopping a bundle of cane, raced his leg home!

Waste Mud Saved To Build New Land

There are no dust bowls in Hawaii—the scarce land is guarded as is water. One plantation saves the mud that clings to cane, pipes it off to barren coral areas, and so builds 10 acres of new land each year.

Moist soils trampled by heavy equipment lose oxygen and turn sour. Planters worry now that, in their rush to mechanize, heavy tractors, cranes, and trucks will compact soils and impair their fertility. "But mechanize we must," says Hawaiian Sugar Planters' Association president, Richard G. Bell. "Paying the highest agricultural wages in the world, about $8 a day, we can compete only by practicing scientific, industrialized agriculture."

One current experiment, if successful, will revolutionize world sugar processes. By ion exchange, chemicals get more sucrose from cane juice and convert it into white sugar at the mill, and thus it may eventually replace today's refining process. I tried ion exchange sugar. It was every bit as good as the sugar on the table at home, but not yet so pretty. Last year sugar and its by-products brought Hawaii an income of $101,000,000.

Pineapple is the flamboyant, widely advertised younger brother of sugar. Of age now, it competes for labor and some land and brings in about a fourth less income (page 588). There is a family fight whenever sugar planters "seed" clouds for rain and so rob thirsty pineapple fields; or spray 2, 4-D by plane to kill weeds and carelessly let chemicals drift onto the delicate "pines."

Pineapples Don't Grow on Trees

But pineapple growers have borrowed freely from sugar experience. With the same emphasis on science, they spray iron sulphate over deficient plants, use hormones to spread the ripening season, and even try to grow fruit to fit the can!

Asked what interests tourists most about pineapple, Boyd MacNaughton, a Dole vice president, answered: "That they don't grow on trees."

Many Americans do not know how fresh pineapple tastes and smells; canning changes flavor. Recent fresh-freezing developments have salesmen puzzled. Will the public desert the canned, or think fresh fruit tastes all wrong?

As yet, only the human eye and hand can select fruit when exactly ripe, but canneries are a maze of machines so intricate that they might well be making telephones. Pineapples are trimmed, sized, and cored by devices called "ginacas," about 100 to the minute. When canned, cooked, and cooled, they are labeled by other machines at 1,300 cans a minute—faster than most machine-gun fire (page 573).

Everything about a pineapple is used except the smell. Once juice pumped out as waste discolored Honolulu Harbor. Now its sale has about doubled the business. Pineapple shells are chopped up and dried to make cattle feed. Citric acid is a major by-product, and researchers strive to make mulch paper, used in planting the pines, from the leaves (page 599).

Pineapple is a fairly new business. James D. Dole, fresh out of Harvard, started it in 1903 with a pack of nearly 2,000 cases. Today his cannery turns out that much in 15 minutes.

Future growth here is limited by the scarce land. Growers, therefore, well aware that pineapple is not indigenous to Hawaii, look afield. California Packing Corporation (Del Monte) is rebuilding in the Philippines; Libby, McNeill & Libby is prospecting possibilities in Mexico; Dole announces experimental plantings in Cuba and a cannery venture in Mexico.

Nature Has Freakish Ways in Hawaii

The green carpet of sugar and pineapple, looking so smooth from the air, belies the rugged nature of these islands. Theirs is a turbulent geologic history. The eruptions, [illegible] on them since Tertiary times are recorded by sea shells 100 feet above sea level and by submerged, coral-encrusted sand dunes, distinguishable in the surf only at low tide. Only three years ago (April 1, 1946) a seismic wave inundated acres, killed 200, and destroyed millions in property.

Such violence has built much of interest.

From the Pali (Nuuanu Pali), spectacular pass between Honolulu and windward Oahu (page 590), one may look out over 30 miles

* See "Land of the Painted Oxcarts (Costa Rica)," by Luis Marden, October, 1941.

A Filmy Cloud of Fibers Clothes Especially as a Lasso, Drops on Unsuspecting Fish

[illegible] Parker [illegible] the single art of having a can of [illegible] but [illegible] lines to his arches [illegible] fish [illegible] strike has pre[illegible] lessons [illegible] make [illegible]

[illegible] including Edwin W. Pau[illegible] Cocoanut Island, where [illegible] Wind blows so hard through this missing tooth in the Koolau Range that a would-be suicide leaping from a height of hundreds of feet [illegible] gently [illegible] Hawaii. [illegible]

[illegible] dotting the rocky coast.

Beaches of "barking" sand that crackles underfoot fringe Kauai, northernmost island. Waimea Canyon, a gorge more than half a mile deep, is Kauai's colorful miniature of the Grand Canyon of the Colorado (page 606).

Natives once looked to Nature for their gods—and no wonder. The visitor who greets an icy sunrise at the crater of Mauna Loa [illegible] on Hawaii [illegible] Valley [illegible] Waimea River and [illegible] rise from plateaus which are themselves well above sea level. The Big Island [illegible] Island) [illegible] volcanoes, Mauna Loa [illegible]

Mauna Kea, climb straight up from the ocean's bottom to nearly 14,000 feet above sea level (page 604).

On their slopes range the bulk of Hawaii's cattle. Parker Ranch alone operates 300,000 acres, thus forming, like Texas' King Ranch, one of the largest family land interests in our country. The heir to this principality gave up cowpunching for juvenile parts on Broadway.

On boat day Big Island cowboys, called *paniolos*, drive cattle in bellowing, unhappy herds down to the beaches, then swim them out through the surf to ship's tackle.

The saddle between the Big Island's volcanic peaks is crossed by a military road built during the war to permit rapid shifting of defenses. To drive this route is to thumb through Doré's engravings for the *Inferno*. Miles of lava, overlapping flows, though cool now, inspire awe. On such a ride I saw no living thing—only sullen black rivers of rock.

Legends spring from this Nature the natives knew to blend with early Hawaiian history. Some doubt that *menehunes*, the strange mountain dwarfs of Hawaiian legend, built a two-mile ditch or kanal overnight. Many believe that Kamehameha I, first to conquer all the islands, was born under rare thunder and lightning and was smuggled that night to another island for safekeeping. It is fact that, in the way of Hawaiian chiefs, he lies buried now in some secret lava grotto.

One day eight years ago Jap planes roared over us, dropped bombs, and strafed. From the carefully preserved "souvenir" bullet holes in a sugar mill near Pearl Harbor to the 80 miles of airplane runways, mostly built by military engineers, the war is still in evidence.*

Tunnels leading to underground shops, hospitals, and ammunition dumps lattice the walls of Oahu gulches, and $100,000,000 worth of surplus jeeps, planes, cranes, and trucks still rust in military order on the islands.

Red Hill, a view spot northwest of Honolulu, is but a shell of earth bottling the oil needs of the Pacific Fleet at war. Costing $42,000,000 and 16 workmen's lives, this storage serves Hassy's long range raids, is atom bomb-proof, and its miles of galleries are serviceable as shelter for Pearl Harbor personnel.

Above this maze of tanks wild deer scurry, and dove and pheasants rise. Hawaii has good hunting, particularly on outside islands, where wild boars course the wooded mountain slopes and herds of mountain goats range the grazing lands.

A Federal bird sanctuary extends from Niihau Island through French Frigate Shoal to Kure, or Ocean Island, 1,400 miles northwest of Honolulu.† Terns, frigate birds, albatross, boobies, and other species people these northern islands; the main group has its sparrows, hill robins, and—a recent importation—the cardinal. In the fall, migrant golden plover from Siberia and Alaska settle here by the thousands; some few fly on to winter as far south as Australia. Most common of all are mynas, native to southern Asia.

Mynas often talk. I know one canny bird named "Joe," brought up near a Marine camp. He calls the family dog by name, demands breakfast, observes that "Colonels are stupid," even whistles when girls go by!

Fishermen Hunt Prey with Submarine Lights

In surrounding waters Hawaii's fishing fleet patrols, catching nearly 5,000 tons of *aku*, Hawaiian tuna, annually (pages 574 and 596). Fishermen spend half their time looking for bait, half the remainder looking for fish. To increase the catch, Hawaiian Tuna Packers, Ltd., has developed colored underwater lights to lure bait and is equipping a boat with wartime submarine listening devices, hoping to hear schools of tuna the eye alone can't find.

This Hawaii that wants to become a State is the focal point of our western defenses and capital of the new war-won American Pacific. From here the ground and air forces scattered on the islands west to Guam are commanded, as are atom-bomb experiments at Eniwetok. Here is the Commander in Chief of the Pacific Fleet, with his civil assignment as administrator of the Pacific areas held by the U. S. as trustee for the United Nations.

Main barrier to Hawaiian statehood is her very substance, the source of her life and income—water—these 2,400 miles of water that separate her from mainland United States. [illegible] Distance means little today. We have instantaneous radio, teletype, and telephone service. We are less than 10 passenger hours from the west coast by plane, and there are 50 flights from Hawaii to the mainland each week.

Our arguments for statehood are these: We pay more Federal income taxes than 12 States; we have demonstrated our capacity for self-government and our loyalty. We [illegible] joined the Union as a Territory, [illegible] statehood promised. By every standard of democracy we have earned it."

* See, in the National Geographic Magazine, [illegible] on the Hawaii "Front" [illegible] by Frederick [illegible] October 194[illegible]

† See, in the National Geographic Magazine, [illegible] "Life Among Lava Rock and Coral Sand," by Alexander Wetmore, July, 1925.

Hawaii Express Beauty and Fragrance by Air. Flower Express Is a Million-dollar Business

Mauna Loa's Lava Slope, Cold and Silent, Looks Out Across a River of Clouds to Snow-flecked Mauna Kea

Diamond Head, Honolulu's Volcanic Beacon, Is Known to Many, but Few Since Airmen Glimpse Its Dead Crater

Wallace Canyon, with Its Contrast Crags, Bristling Cactus, and Desert Flowers, Gives Rare Delight to Arizona Lands

Hes Dubeck Stevens and Chief of Pueblo's Bates Plants, Grows Over Weldon Hawkins, Cancer as Well as the Mesa

Pacific's Rough Surf Batters and Scours Makapuu Beach. Body surfers Who Have Ridden a Wave to the Beach, Appear Lost

A Waist-stretching *Luau* or Native Feast, Is Hawaii's Answer to New England Clambake and Texas Barbecue

A Sugarcane Plume Strides above the Palms on Spider's Waikiki Lanai, Island of Hawaii

New Discoveries on the Mid-Atlantic Ridge

By Maurice Ewing

Professor of Geology, Columbia University

[illegible] to the Mid-Atlantic Ridge

Illustrations by National Geographic Photographer Robert F. Sisson

"S[illegible]! As this cry sounded, all hands crowded to the rail of our little research ship *Atlantis*, rolling easily as she lay hove to on the gray midocean swells.

It was a tense but eagerly awaited moment on our second voyage of exploration of the Mid-Atlantic Ridge, the world's longest mountain range, which runs a full mile deep under almost the whole length of the Atlantic Ocean.

We were about to probe deeper down into the mud on the Atlantic's sudden bottom than we ever had been able to penetrate before. This meant that we would be reaching far back into the ancient history of the Atlantic Ocean, and even of the earth itself, a history preserved in the sediments that had been piling up on the sea bottom for many millions of years.

Taking core samples of the ocean bottom was just one of the many scientific projects in our exploration of the Ridge under the sponsorship of the National Geographic Society, the Woods Hole (Massachusetts) Oceanographic Institution, and Columbia University, New York City.

Exploring the Undersea World

Swung out over the [illegible] starboard side was our new and improved coring apparatus, with which we would delve into the dark, silent undersea world.

It was a 40-foot steel tube, two and a half inches in diameter, with a sharp cutting edge on the lower end and 1,000 pounds of lead weights on top to drive it down into the mud of the ocean floor.

Double the length of tubes we had previously used, and now equipped with a piston to help pull up the mud inside, it would enable us to penetrate twice as far down into the bottom sediment as we had gone before.

We were ready now to lower this tube on the end of two to three miles of steel wire, set it drive itself deep into the bottom mud, as a corer is pushed into an apple, then pull it out and haul it back to the surface with the core of mud inside for analysis.

Mud from the Atlantic Ocean bottom is slimy, unglamorous-looking stuff, as is mud from anywhere (page 623). But in that mud we can read a chronological history of everything that has happened in and around the Atlantic Basin far back into Ice Age times—evolution of life, changes of climate, risings and sinkings of the ocean bed. We need to learn more about all these things.

Our ship lay over the western "foothills," or terraces, of the Mid-Atlantic Ridge, almost two miles straight down beneath our keel. Thick fog hemmed us in, and our foghorn was sounding a nerve-shattering "ola-a-a" at frequent intervals.

This was the first test of the improved, longer coring apparatus we had built since our last voyage. Would it work? If by mistake we hauled the corer in before it actually hit bottom, or if the trap device failed to let it fall freely the last 10 feet, it would not secure as good a sample as the old shorter tubes, and hours of work would be wasted. If the wire kinked or fouled, it might break, causing the loss of our tube and perhaps thousands of feet of valuable wire as well.

No wonder then that we all felt a little tense as Capt. Adrian K. Lane, called out, "Cast off and stand clear!"

As he pushed the control lever, a grinding roar came from the big winch down in the hold, the heavy steel wire rattling and slapping as it unreeled into the sea.

After about an hour, when we had paid out nearly three miles of wire, its tension suddenly slackened—the coring tube had hit bottom. At once the winch was reversed, the tension gauge showed the sudden strain as the tube was pulled out of the mud, and then began the long haul up.

As soon as the tube was visible under water alongside, I sang out, "In sight!" Then, as it came up and broke water, "Surface!"

This signaled the captain to slow down the winch, then stop, and the corer was hoisted aboard. A smear of mud on the outside showed that the tube had successfully penetrated 20 feet into the bottom.

We found that this 20 feet of mud repre-

* See "Exploring the Mid-Atlantic Ridge," by Maurice Ewing, National Geographic Magazine, September, 1948.

Stout Hook and Chain Bag on Angry Sharks

[illegible]

[illegible] scientist at least [illegible] ages of the earth's past history. It tells a story of climate [illegible] the Tertiary age when [illegible] volcanoes and retreating sea land and [illegible] and types of sea creatures [illegible]

[illegible] the scientist [illegible] the east [illegible] the pelagic [illegible] taking [illegible] some minutes fathoms [illegible] chart the [illegible] of parts of the [illegible] investigating the type of bed [illegible] through the mean floor, the [illegible] sediment covering it and [illegible] deposits [illegible] around it.

This time we were [illegible] series, exploring the [illegible] of four months, from the latitude of Newfoundland almost to the [illegible] of South America, and [illegible] also the great flat plains on the [illegible] floor that flank the Ridge on either side (main page 614)

Origin of Atlantic Basin

[illegible] we gathered on this second [illegible] will help give a better [illegible] of the origin, age and history of the gigantic Atlantic Ocean [illegible] This great water-filled depression might have come into existence [illegible] the Atlantic [illegible] seeking to [illegible]

[illegible] may once have been [illegible] and Africa [illegible] great [illegible] opening up the Atlantic [illegible] turned in the [illegible] of continental [illegible] that [illegible] other parts of the earth [illegible] boats were forced [illegible] level in the [illegible] to [illegible]

[illegible] of the third [illegible] second cruise create new [illegible] of prehistoric [illegible] samples of the [illegible]

"Let's Try for Underwater Pictures Here" Dr. Ewing and His Staff Discuss Plans

[illegible]

[illegible]

Two Startling Theories

[illegible]

[illegible]

[illegible]

will add much to our knowledge of the past history of the Atlantic.

On this second expedition, too, we made the first photographs in natural color ever secured in the sea at depths below 600 feet (100 fathoms).

Sound Echoes Measure Depths

In more than 3,000 different places over vast areas of the Atlantic we have now measured with sound echoes the depth of the sediment on top of the bedrock of the ocean floor.

These measurements clearly indicate thousands of feet of sediments on the foothills of the Ridge. Surprisingly, however, we have found that in the great flat basins on either side of the Ridge this sediment appears to be less than 100 feet thick, a fact so startling that it needs further checking.

Seeking to learn the nature of the Atlantic's bedrock, whether it is basalt or granite, we measured the speed of sound traveling through this rock. Sound travels faster through basalt than through granite, and our tests, though incomplete, indicate that these "basement" rocks are probably basalt. If this is true, it seems that the Atlantic Ocean basin might be as old as the earth itself and was not formed by the sinking of an ancient land mass.

One important achievement of our expedition was the tracing of a continuous profile of the contours of the bottom over large areas of the North Atlantic. This provided for the first time a complete and accurate picture of the slopes and peaks of many parts of the Mid-Atlantic Ridge and the smooth, wide flat plains that extend for hundreds of miles on both sides of it to the continental shelves.

All this was done with our continuously recording deep-sea fathometer, which measures the depth of the water by the time it takes for a high-pitched sound signal to echo back from the bottom (page 617).

An Atlas of the Ocean Floor

Our record of the topography of the Atlantic's bottom, made on these expeditions and other recent *Atlantis* cruises, covers a total of 60,000 miles and is drawn on strips of paper that if joined together would total 1,200 feet in length (page 613). It forms a priceless library of the first detailed information gathered on certain areas of the bottom of the sea.

The record shows unerringly every "pimple," every peak and cliff, every rise and dip in the sea floor. On it we discovered many new uncharted "sea mounts," confirmed the existence of others previously reported, and also proved the nonexistence of some shoal areas that had been erroneously marked on earlier charts.

An interesting recent discovery made with our fathometer was that the submerged canyon of the Hudson River, a continuation of the Hudson Valley, extends 100 miles farther out under the sea than anyone had known before.* Several years ago the Hudson Valley was charted out under water to the edge of the continental shelf, 120 miles offshore.

Tracing the Hudson Canyon

But on this trip our fathometer found a slight dip even farther out. We have now traced this canyon for another 130 miles across a lower, second slope on the edge of the continent, in water one and a half to two and a half miles deep. Here the valley is two to three miles wide and 300 to 1,800 feet below the level of the shelf through which it cuts.

If all this valley was originally carved out by the river on dry land, as seems probable, it means either that the ocean floor of the eastern seaboard of North America once must have stood about two miles above its present level and has since subsided, or else that the level of the sea was once about two miles lower than now.

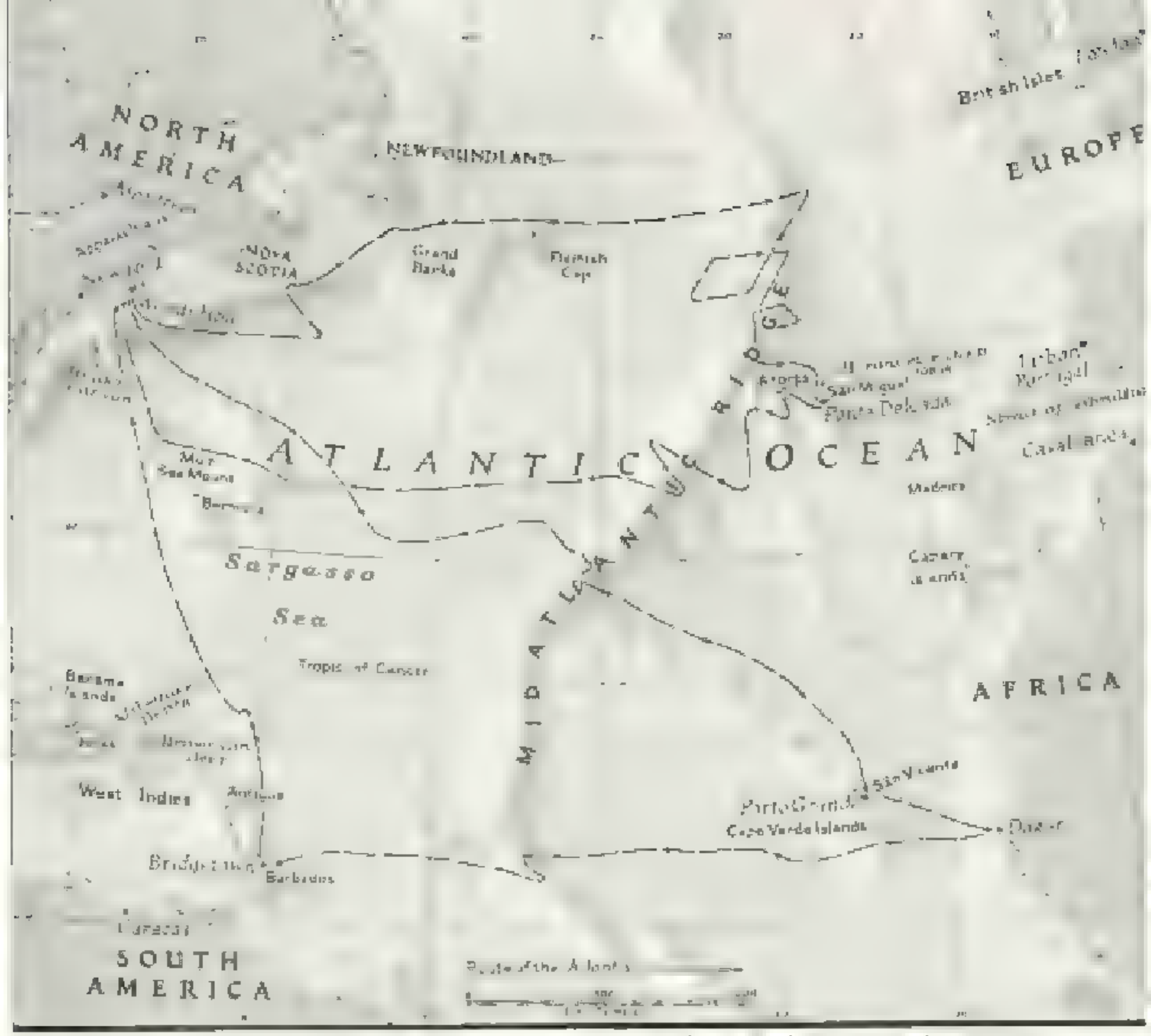
Another mystery of the sea, as yet unsolved, showed up again on our fathometer, as it had the year before. This is a strange echo that in the daytime is reflected from about 300 fathoms (some 1,800 feet) down and is entirely separate from the echo sent back from the ocean bottom. At night this unusual echo comes from near the surface.

Everywhere in the sea we found this echo. It may come from the plankton, vast hordes of small sea creatures which move up near the surface at night and sink during daylight. It has been suggested, however, that the echo might come from great schools of fish far out in the open sea where no one was thought they existed.

Should this be true, the sea may contain greater resources of food than anyone has suspected. We again gave the data we gathered on the echo to Dr. H. B. Moore, who is studying the subject at Woods Hole.

We dredged up rocks of igneous, or "fire-made," type from the sides and tops of peaks on the Mid-Atlantic Ridge, which indicated that submarine volcanoes and lava flows have been active there. Probably the whole Ridge is highly volcanic, with perhaps thousands

* See "The Mighty Hudson," by Albert W. Atwood, NATIONAL GEOGRAPHIC MAGAZINE, July, 1948.



Vessel Followed a Zigzag Course Across Ocean's Hidden Mysteries

Sequents from Woods Hole, Massachusetts, made 19 [illegible] Mid-Atlantic Ridge Expedition. The first trip [illegible] Sea and the waters around Cape Verde Islands [illegible] Fourteen days in Antigua [illegible] for Azores. While [illegible]

[illegible] outcroppings and active and extinct [illegible] scattered along its entire length.

With the Blake trawl, a long conical net with a yawning mouth, we hauled up specimens of deep-sea life, among them a ghost-looking fish whose lower jaw slid in and out instead of opening in the usual way (pages 624, 625, and 640).

Once we were surprised to find pieces of lettuce in the trawl, until we realized the mess boy had dumped some table refuse over the side just before the trawl was hauled to the surface.

Behind the ship we towed what we called "the fish," a magnetometer that recorded changes in the magnetism of the rocks on the bottom far below. The first time this had been done in the ocean basins. Rocks of igneous origin are strongly magnetic. When the mag-

[illegible] that we were passing over old lava [illegible] or volcanic areas on the sea floor.

At such times our fathometer often would show a mountain or small rise on the bottom at the same point, confirming that there are many peaks of volcanic origin scattered over the Atlantic Basin.

Ridge's Peaks Rise to Form Islands

Its peaks and ranges, as rugged and precipitous as any mountain range known on land, rise about 10,000 feet above the level plains on either side. These plains average about three miles below the surface. Only a few of the Ridge's highest peaks emerge above the water surface to form the islands of the Azores, St. Paul Rocks, Rocheles San Paulo,

Ascension, Tristan da Cunha, Gough, and Bouvet.*

There is no reason to believe that this mighty underwater mass of mountains is connected in any way with the legendary lost Atlantis which Plato described as having sunk beneath the waves.

Our ship, the *Atlantis*, research vessel of the Woods Hole Oceanographic Institution, is a 146-foot steel hulled ketch, specially designed for oceanographic work. She travels [illegible] range out of all proportion to her size. An auxiliary Diesel engine provides motive power when winds fail.

As on the previous cruise, we carried a crew of 18, commanded by Captain Lane, formerly of the U. S. Coast Guard, and a scientific staff of ten. Robert F. Sisson, National Geographic staff photographer, made the cruise to obtain a pictorial record of our work.

Weighing anchor at Woods Hole, we soon were under full sail eastward.

One of our new and welcome pieces of housekeeping equipment was a deep freeze, which insured plentiful supplies of fresh meat and vegetables.

Stowed in the hold, on deck, and anywhere else we could find space were rock dredges, coring tubes, trawl frames, cases of bottles for preserving biological specimens, boxes for rock specimens, etc.

Wound on the three winches were more than four miles of half-inch steel-wire rope for lowering our coring tubes and dredges, five miles of 5/32-inch wire for the deepsea camera and the bottles for collecting water samples from the depths, and 2,000 feet of 3/32 inch wire for sending down our temperature and pressure-measuring instruments (page 640).

Toy Balloons and TNT

An important, if bizarre, item was 2,000 brightly colored toy balloons to be used as floats for the TNT charges we exploded for measuring the depth of bottom sediment. We carried 4,500 pounds of TNT, stowed on deck where it could be quickly thrown overboard in case of fire (page 620).

Schools of porpoises frequently turned up to escort the ship, diving under the bows and playing about. A few cases of seasickness soon cleared up and all hands began getting settled in the cramped quarters and learning to stand watches on some of the scientific projects that went on day and night.

Once every hour, around the clock, we set off a "reflection shot" to measure the depth of sediment on the ocean bottom. A small charge of TNT was attached to a couple of toy balloons for floats and flung over the side with the fuse ignited (page 622).

When the charge exploded, the sound waves traveled down through the water to the bottom. Some were reflected back to the surface from the mud on the sea floor, but others went down through the mud and were reflected back from the solid bedrock below. The difference in the time it took for the two [illegible] established the depth of the sediment.

Often sea gulls and petrels were attracted by the bright colors of the balloon floats, only to fly off with loud squawks of injured dignity when the underwater explosion showered them with water.

Shark Gets Dose of Castor Oil

Sharks were more troublesome kibitzers. Suddenly the hydrophone would fail to work, and we would find the tips of sharks' teeth imbedded in the towing cable (page 612). One shark bit off some celluloid tubing and her sheathing, and a good dose of castor oil used in the sound pickup apparatus. We felt the castor oil served him right!

These ocean-bottom sediments we measured are formed from the shells and skeletons of countless small sea creatures that die and sink year after year; from volcanic dust and wind-blown soil drifting out over the sea; and from the ashes of burned-out meteorites and cosmic dust from outer space sifting constantly down upon the earth.

Near the coast, where much material from land is carried out into the water, one or two feet of sediment may be deposited on the ocean floor in 1,000 years, and farther out near midocean only half an inch may be laid down in the same length of time. This is known from the age of fossils found in the mud and the amount of radium in various layers, which is also a measure of age.

Always it had been thought the sediment must be extremely thick, since it had been accumulating for countless ages, like snow in Arctic areas. But on the level basins that flank the Mid-Atlantic Ridge our signals reflected from the bottom mud and from bedrock came back too close together to measure the time between them. These echoes are complicated, but we think we are reading them correctly and that they show the sediment in the basins is less than 100 feet thick!

* See "Our Global Ocean: Last and Vast Frontier," by F. Barrows Colton, NATIONAL GEOGRAPHIC MAGAZINE, January, 1945.

Mileadeep Mountain Reveals Itself on the Fathometer

Submerged Peak of the Appalachians?

Life on *Atlantis* by now had settled into the normal routine of long hours of work and too little sleep (page 625). As Bob Sisson said, "The only way we knew it was Sunday was that the cook served turkey for dinner."

What little sleep we did get was broken by the hourly explosions of the bottom-sediment measurements and the roar of the big winch lowering or raising a coring tube or dredge. Below decks the winch sounded like a whole squadron of B-29's passing low overhead!

Beards sprouted, and a stream of salt water from a hose on deck provided the only chance for baths. One strict rule was that shirts must be worn at table. Though we had to eat in shifts, meals were regular and ample. There were always cheese, sausage, bread, and coffee ready in the galley for the men on night watches.

Now and then a gang off watch would gather below to sing old chanteys to the accompaniment of Captain Luze's accordion.

We washed our own clothes with strictly rationed fresh water, and almost always the rigging was decorated with odds and ends of underwear, T-shirts, and towels hung up to dry.

Ship Stopped to Bake Bread

Sometimes we had to heave to to let the cook bake bread. When the ship was under way in heavy weather, her steady pounding against the waves would prevent his bread from rising, but not his temper!

Crossing the Ridge, we drew a detailed profile of its peaks with our fathometer. Flanking the central highlands we found deep trenches separating the main Ridge from the lower terraces on either side. These trenches drop down to depths of more than two miles, while the central peaks of the main Ridge are approximately one mile under water.

We found similar trenches when we again crossed the Ridge farther south, but do not yet know whether they run its entire length.

These trenches may mark the locations of the great faults that undoubtedly extend somewhere through or near the Mid-Atlantic Ridge and which are the sources of many submarine earthquakes that center there.

In these ditches and in other deep places we lowered thermometers to get the temperature of the water far down in them, a clue to whether they are canyons or enclosed basins. If basins, the water would be comparatively warm, because the cold water of the ocean bottom could not flow into a basin entirely surrounded by walls.

Turning south, we cruised along the eastern flank of the Ridge, with our fathometer drawing a picture of terraces between two and three miles deep under our keel.

Farther along, in a depth of 3,600 feet (600 fathoms), we found rocks that tell an interesting story about the past history of the Atlantic Ocean. We photographed some on the bottom that were over a foot in diameter and those we brought up in the dredge proved to be granite and sedimentary rocks of types which originally must have been part of a continent.

Most of the rocks that we dredged up here were rounded and marked with deep scratches, or striations. This was a good indication that they had been brought out here by ice, for it showed that they had been dragged over other rocks while in the grip of the glaciers on land. But we also found some loosely consolidated mud stones, so soft and weak they would not have held together in the iron grasp of a glacier. How they got out here is another riddle to be solved by further research.

Crossing the Ridge again to the westward, we stopped to make one of our frequent measurements of the speed of sound through the basement rock beneath the sea bottom, to see if it was basalt or granite.

In these tests the *Atlantis* served as a listening post for explosions set off from the whaleboat, which sailed off about 12 miles. A beam from the ship's radar, reflected off a target in the boat, gave an accurate measure of the distance. When the boat's crew set off TNT charges in the water, the sound traveled down through the bottom sediment, horizontally through the bedrock, and up through the sediment again to the ship's hydrophone.

Uncharted "Sea Mount" Found

As we sailed toward the Azores our fathometer revealed an uncharted "sea mount" on the bottom, about half a mile below the surface. Near by we lowered our coring tube again in a depth of 8,000 feet on the Ridge itself and brought up a core 23 feet long. It contained many layers of volcanic ash, probably from eruptions in the near by Azores.

Running south parallel to the Ridge, we crossed the Hirondelle Deep on the Azores plateau, the base of the islands, where our fathometer showed a giant hole dropping down to 1,800 fathoms, as if a volcano had caved in there at some time in the past.

As we neared Ponta Delgada on the island of São Miguel, the ridges and valleys 100 to 300 fathoms beneath us seemed almost to replicate the terrain above water on the island ahead (page 628). Going ashore we stood dryshod on one of the few points where

From Two Miles Deep — "Tunnel Brings Up Mud Testing at the Seas Anchors" First

Swords into Plowshares: Surplus Navy TNT Is Loaded on *Ithaca* at Woods Hole for Dispersing the Sea Floor with Sound Waves

[illegible]

Has the Camera Ever Been Stacked Up With Will Tell?

[illegible]

Sees Transmitters Be Measured with Colored Disks

[illegible]

Explosions of TNT Probe Deep Below Old Ocean's Bed

Davy Jones's Locker Yields Some Secrets: Bottom Mud Dug Out with a Coring Tube, and Creatures from the Depths

What Queer Fish Has the Diver Caught Now? Sailors Watch the Net Break Surface

Storm and Dark Dan's Dungeon Conversing About Secrets of the Sea

Tressely Does Water for Wine in Sacken Showing Jesus Is no Beliver

White Houses of Ribeira Grande, Azores, Stretch Back from the Sea to Cockleburred Fields Climbing the Hillsides

[illegible]

Spray and Big Seas Tempt "Southerners" Fallen Locks Despite Washing Decks

[illegible]

Pastel-hued Ponta Delgada Sky Between Green Hills and Blue Sea, Is a Lovely Backdrop for Portuguese Flag

[illegible]

Where Texas Once Secluded Now Nestles the Town of Furnas in Its Extinct Crater on San Miguel Island

Twin Lakes of Hourglass Shape Fill an Azores Volcano Crater. Where Legend Says Seven Cities Once Stood

"Who's Your Dentist?" One Might Ask

Shyness Yields to a Tasty Sandwich

A Wheeled Pole Makes Carrying Papa's Lunch Easy . . . Saddle Tiles Keep Usable Irish Lands on Steep Slopes

"All Together Lads, and Up She Comes!" Portuguese Fishermen Drag a Boat from the Water After a Day's Work at Sea

Post Banks of Hydrangeas Make Gates Usual Produce on the Azores Coastal Road

[illegible]

the Mid-Atlantic Ridge actually reaches above the level of the sea.*

After weeks with almost no word from home, all hands avidly devoured the big stack of mail courteously brought to us at the dock by U. S. Consul Clifton R. Wharton.

Also on hand to greet us was Jose, the local barber, who had done a land-office business when we touched here the year before. But this time everyone had fresh haircuts given on board the *Atlantis* by seaman Otto Salberg, and poor Jose got not a single customer.

While the ship took on fuel oil, water, and other stores, some of us tried the Portuguese version of a banana split at an "American" soda fountain, while others satisfied their craving for fresh fruit by consuming Azorian apples, pineapples, grapes, and bananas.

Shore Interlude Enjoyed

A few of the crew moved into the local hotel to enjoy hot baths and a brief respite from the crowded, noisy sleeping accommodations on the *Atlantis*. Most of us toured the island to enjoy its rugged mountain scenery and get acquainted with the hospitable friendly people who made us welcome everywhere (pages 631, 632, and 633).

Volcanic eruptions built the Azores above the sea (page 629), just as similar eruptions have undoubtedly created many of the underwater peaks of the Mid-Atlantic Ridge that we had charted.

One volcano at Furnas, on the eastern end of São Miguel, is still active enough to produce numerous hot springs in its crater, the site of a health resort where people come to drink and bathe in the sulphurous waters. In the crater of another volcano are two lovely lakes, one green, the other blue, though they are separated by only a few yards of land (page 630).

While we were at Ponta Delgada, one of the Western Union's transatlantic telegraph cables broke just off the Azores. Later the company inquired whether we were operating in the vicinity at the time, suspecting perhaps that one of our coring or dredging operations might have caused the break. But since *Atlantis* was tied up at the dock when the break occurred, we were able to plead not guilty.

As we sailed on westward from the Azores, the probing finger of our fathometer found two more new sea mounts rising from a depth of about a mile and a half to within 1,200 and 3,600 feet below the surface; then we passed over a gently sloping area of the bottom about 1,800 fathoms deep, interrupted by low mountains.

Next day we zigzagged back over the Azores platform, a submarine elevation a mile and a half deep on which the islands stand. This platform is covered with thick sediment, the first place we had found where there was such a thick layer on the highlands of the Ridge, where usually the sediment is thin.

Passing off the platform and out over the deeper basin, which plunges down to 1,800 fathoms again, we made a photograph of the ocean bed. It shows mud penetrated with small holes, quiet little trails apparently left by something moving along the bottom, and mounds two or three inches wide. What made them is a mystery.

We took our first deepsea color photographs on top of a sea mount discovered the year before and on its flanks in 900 to 2,400 feet of water. One showed ripples in the bottom sand which must have been made by underwater currents, though no one had believed that currents reach to depths as great as this.

Other photographs showed many of the mysterious objects known as "sea biscuits," round pieces of rock several inches in diameter, one-half to one inch thick, and concave like a saucer on one side. Later our dredge brought up two large hauls of sea biscuits for further study.

None of our pictures happened to catch starfish, clams, and other forms of life usually found at this depth, but we hope another time to send down bait or light lures with the camera to attract sea creatures into range. We proved at least that color photography at the deep sea is possible, and in the future will be a valuable tool for exploring the ocean depths.†

Small Rock a Valuable Find

Lowering our dredge, we tried to drag it up the steep side wall of the mountain to scoop up rocks. It stuck fast, but after much maneuvering somewhat like playing a fish on the end of a mile-long line, it came loose, bringing up only a single three-inch rock freshly broken off the cliff.

This small rock proved a valuable find. Its structure indicated that this sea mount is an ancient volcano that once may have stood above the sea, since its original peak has been

* See, in the NATIONAL GEOGRAPHIC MAGAZINE, "New Map of the Atlantic Ocean," by Leo A. Borah and Wellman Chamberlin, September, 1941; "European [illegible] The Azores," by Harriet Chalmers Adams, January, 1935; and "American Airmen in the Azores," 10 pls. in color, February, 1941.

† See, in the NATIONAL GEOGRAPHIC MAGAZINE, by William Beebe: "Half Mile Down," December, 1934, "Wonderer Under Sea," December, 1935; and "Depths of the Sea," January, 1952.

eroded down to the flat top it has today. The rock contains many fossils which may enable us to determine the geologic period during which the peak was eroded.

But now bad luck overtook us. Hoping to scrape up more rocks from the mountainside, we lowered the dredge once more. Again it stuck fast, and this time all the captain's efforts to dislodge it failed. There was nothing to do but break loose by main strength.

All hands were ordered off the decks and below, for if the wire should break near its upper end its terrific backlash could easily kill or badly maim anyone it struck. Then the brakes on the winch drum were set tight, and the order was given for full speed ahead. Since the wire parted far down near its lower end, there was no backlash, but we lost a dredge and a specimen of submarine rock that we wanted badly.

More bad luck dogged our course. We wanted to sail farther to the southwest to explore again another section of the Ridge that we studied in detail the previous year, but adverse winds kept us from it.

For three days we crossed and recrossed the Ridge, tracing its profile with our fathometer, gathering samples of the bottom, and stopping now and then to take underwater photographs. Some of the pictures showed what looked like "burrows" and "anthills" in the bottom mud, so far unexplained.

For 12 days then we sailed westward, across the terraces on the west side of the Ridge and out over the vast flat plain that extends three miles deep and 500 miles wide all the way to the Bermuda Rise.

All along this route we probed into the bottom with our coring tube, to learn more of the ancient history of this great basin.

Bottom Sampling Tricky Business

Pushing a 40-foot tube down into the mud three miles below you, without being able to see what you are doing, is a tricky business. Though it is lowered on the end of a steel wire, the tube must fall freely just before touching bottom, to insure that the weights on the upper end push it well down into the mud.

To accomplish this, a trigger hangs several feet below the end of the tube. When it touches bottom, it releases a clamp holding the coring tube to the wire and permits it to fall freely.

On our previous voyage, friction on the inside of the coring tubes sometimes prevented sediment from being pushed all the way up inside. This time we rigged a piston which was pulled up within as the tube penetrated the mud, creating a suction that helped overcome friction.

On the Bermuda Rise, the great undersea platform on which the islands stand, we found sediments up to 7,000 feet thick, in contrast with the thin layers on the bottom of the deep basins on either side of it. This sediment extends southwest to the Bahamas. Why this part of the Atlantic's bed is covered with such thick sediment is a geological riddle.

Hurricane Threatens Off Bermuda

This same day the radio brought us news of a hurricane off Bermuda that might catch us before we could get home. But we risked stopping once more to take a core sample on the edge of the lower continental shelf almost opposite the point where we later charted the underwater continuation of the Hudson Valley (page 614).

Deep down in this core was a four-foot section of layers of mud and clay of sharply contrasting colors—red, green, cream, and black. Probably some ancient submarine landslide mixed up the strata to form this variegated color pattern. We wondered if it could have had any connection with the Hudson's underwater canyon.

The hurricane veered out to sea and crossed our track just a day behind us as we sailed into Woods Hole to unload our specimens, recondition equipment, and restock the ship.

Four weeks later *Atlantis* was again at sea, heading this time for a new hunting ground farther south on the Ridge. As I was unable to make this second cruise, Mr. Bruce Heezen, one of my graduate student assistants at Columbia, a veteran of our two previous voyages, headed the scientific staff this time.

For a solid week *Atlantis* sailed southeastward across the great plain on the sea floor, almost unbelievably flat and level at a depth that seldom varied much from 2,000 fathoms (almost three miles), and sloping down to a maximum depth of 2,900 fathoms.

Much floating vegetation was sighted, for the ship was now passing through the famous Sargasso Sea, named for the sargassum, or gulfweed, which is assumed to be torn loose from the bottom in coastal areas of the Atlantic and drifts to this part of the ocean (page 621). Here it multiplies, and is found in an area of about two million square miles. Tiny air bladders keep the weed afloat. I have never seen it forming continuous masses which could in any way impede the progress of a ship.*

But this good luck did not last. As one of

* See "Sandlands of Science," by George Fishbeck, NATIONAL GEOGRAPHIC MAGAZINE, July, 1925.

"Peek-a-boo" Hermit Is Like Old-fashioned Cane Hod

[illegible]

[illegible]

Ship Crosses Another "Fault"

[illegible]

For up the *Marricay* is that modern rarity, a sailing packet, a passenger vessel operating under sail only, with her engines removed. She plies back and forth across the Atlantic carrying Portuguese-Americans at low fares to revisit their homeland. Some of our people visited aboard and found the sturdy old vessel as spotless and shipshape as ever she was when "Capt'n Bob" sailed her into the northern ice packs.

Delay dogged the expedition here. There was no pump to transfer fuel oil, and each drum had to be hoisted aboard and emptied by hand into the *Atlantis's* tanks.

Meanwhile, the hardy aerial resistor for the wind, had been flown as far as Dakar. But no plane was available to bring it to the Cape Verdes, so there was no choice but to go and get it. Eastbound, the fathometer showed that the 40-fathom platform on which São Vicente stands drops off suddenly to a steep slope down to 1,400 fathoms, and then to a 2,000-fathom dish-shaped basin between the Cape Verdes and the gentle rise in the bottom that marks the continental shelf of Africa.

In the very bottom of this basin the fathometer traced two strange trenches about two miles wide but only 300 feet deep. The party found them again farther south as the ship passed over the basin going west and wondered if they could be submerged river valleys like the Hudson trench.

South of the Cape Verdes, after leaving Dakar, the fathometer traced another new sea mount, a volcanic peak that rises a mile high above the bottom around it, which is 12,000 feet deep. From there the bottom sloped gradually down to 15,000 feet (three and one-half miles), before climbing again toward the Ridge.

On the Home Stretch

Sailing west toward the Ridge again, on the home stretch in fine weather, the ship's company had no inkling of what fate had in store for them. South of the Cape Verdes the *Atlantis* was hove to and the coring tube lowered in 2,900 fathoms.

Without warning, when the tube was almost on the bottom, the wire broke only a few feet from where the men were watching it pay out over the ship's side. They had a narrow escape from serious injury, as the broken end whipped back wickedly. Down to Davy Jones's locker went two and a half miles of irreplaceable wire! That was the end of probing the bottom with the 40-foot corer.

As the ship passed into the foothills on the eastern slope of the Ridge the mainsail, weakened after being torn on the eastward trip, tore away again on the lower side. The captain decided not to try to repair it, though circumstances soon were to force the crew to fix it after all.

A new kind of underwater contour showed up on the fathometer here as *Atlantis* crossed the Ridge 1,000 miles farther south than we had explored it before. On the east side the terraces typical of the northern part of the Ridge were missing, and the Ridge itself was narrower and stood lower, well over a mile below the surface. On the west side the usual terraces were found, but with sharper rises and depressions than farther north.

All again seemed well as *Atlantis* sailed on over the great plain of the Atlantic's western basin, when seaman Fred Kent suddenly became ill with pain in his abdomen so severe that he could not eat or sleep. The ship [illegible] speed a course was set for Barbados, three days away, the nearest point where the sick man could get medical attention.

More Trouble!

Still more trouble was on the way. Early next evening, without warning, a loud thud sounded throughout the ship, followed by the noise of the engine racing. The propeller had come loose from the shaft and was useless just at the time it was needed most!

There was no choice except to make the best speed possible under sail; but the mainsail was still unrepaired, and with only mizzen and headsails available *Atlantis* could only limp along at about four knots.

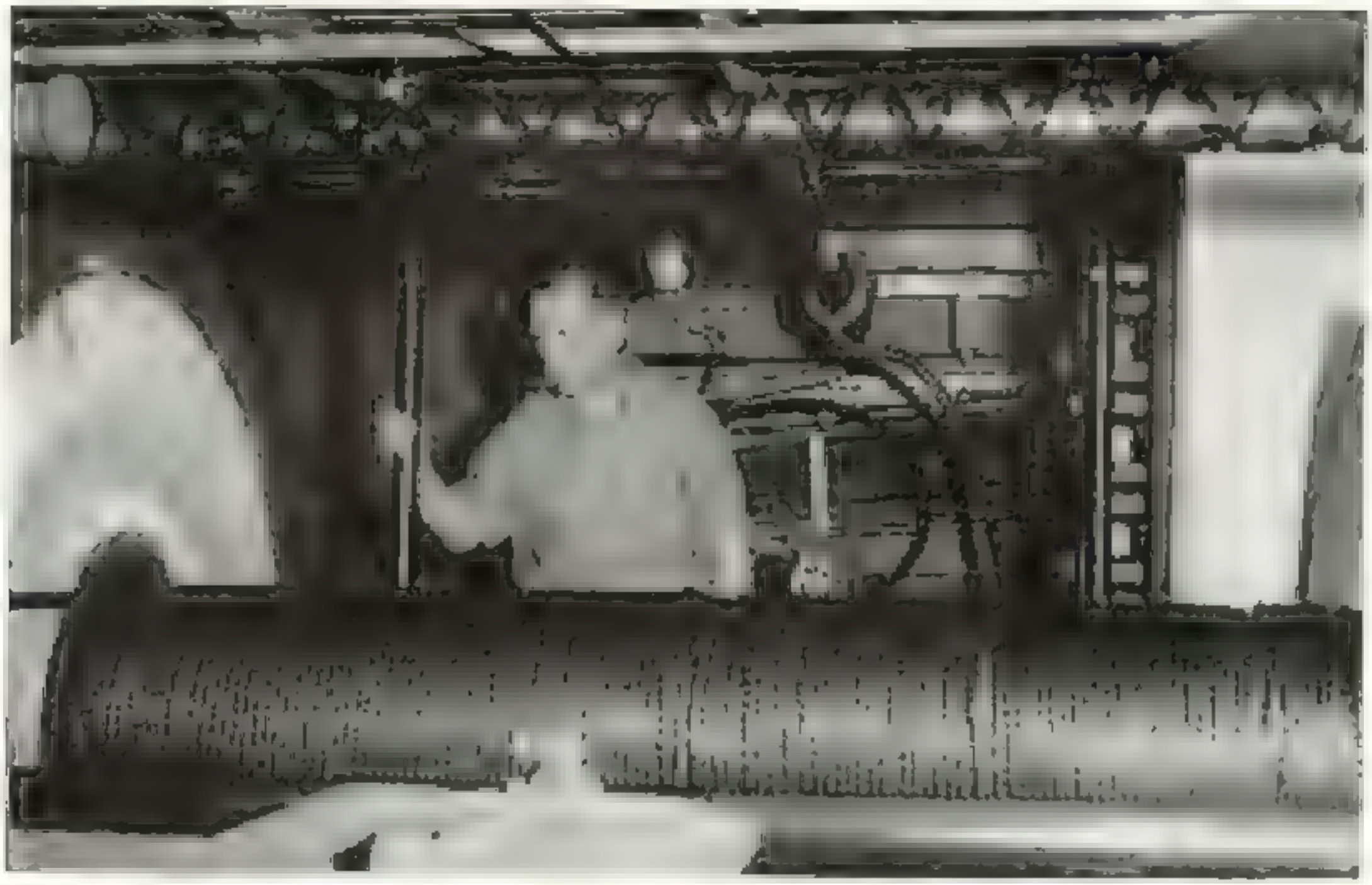
Kent became delirious, and the captain had to keep dosing him with morphine to relieve his pain. Early next morning the propeller fell off and sank. The U. S. Public Health Service radioed that arrangements were being made for a doctor to meet the ship in Bridgetown, Barbados.

All day two of our veteran seamen worked feverishly to repair the mainsail. Then that night the mizzen sail ripped! With only the headsails remaining, the ship made but two or three knots most of the time. At last the repairs on the mainsail were finished, it was set, and *Atlantis* picked up speed.

Routine scientific work went on, but of course no stops could be made to use the camera or dredge. A British tanker out of Bridgetown radioed an offer to take Kent into Barbados, but by the time she came into sight the sea was too rough for a safe transfer.

At last the ship reached Barbados and the sick man was taken to the Bridgetown hospital where he stayed until he was able to fly home.

"Dat Ole Devil, Sea!" Into Rising Steam the Trawl Net Comes Up Loaded and Empty



Four Miles of Cable Wound on This Drum Lowered Corers and Dredges to Sea Floor

[illegible]

Apparently [illegible] Bermuda [illegible] fathometer showed that the bottom [illegible] of the [illegible] suddenly and sharply from the [illegible] level [illegible] as abruptly as the Rocky Mountains rise from the Great Plains [illegible].

[illegible] on the homeward tack at last, Atlantis traveled for a while over the [illegible] platform, about 1,500 feet [illegible] bottom dredge [illegible] suddenly, again [illegible] two miles [illegible].

[illegible] 3,456 [illegible] Later [illegible] Next [illegible] the general [illegible] probably an extension of the [illegible] Deep [illegible] Atlantic [illegible] about three miles deep.

One day a small [illegible] caught the ship [illegible] First Mate Arvid Karlson [illegible] threw the [illegible] the wind [illegible] the sails [illegible] for the moment, but next day another blow ripped it [illegible].

Christmas was now only a week away, but Atlantis, crippled without her engines and propeller, made extremely slow progress toward home. Some of the men, having in mind [illegible] get there in time, built up a little holiday spirit by decorating the laboratory with spare [illegible] old photographic [illegible] and other colorful [illegible].

But [illegible] was not going to let them [illegible] without one more [illegible]. Two days [illegible] the worst storm of the entire cruise hit the ship. A hatch cover was blown off, all sail was furled, and the Atlantis was hove to to ride out the blow. The barometer [illegible] up and down so fast that it seemed as if someone were trying to pump all the air out of the ship.

Then, to top it off, when the storm passed they found themselves becalmed with no wind at all.

But finally [illegible]. A new strong breeze [illegible] the Atlantis sailed into port at [illegible] three days before Christmas.

The Pink Birds of Texas

By Paul A. Zahl

With Illustrations from Photographs by the Author

AT THE DROP of the smallest hat, almost every Texan will sing loud and long praises of his State's cattle, its rice and cotton, its oil and industry, its orchards, skies, coasts, and lands.

There is, however, one natural treasure possessed by Texas, almost alone among the States, about which few of its proud citizens have any knowledge—the roseate spoonbill. This avian treasure lies in the virtual shadow of oil derricks, within sight of tank barges and steamers. It is one that exists in the common domain of the Nation's natural wonders.

To comprehend this spectacular coup of Nature, one must distill the pink from a Texas sunrise and pour the essence over a mass of soft feathers. The feathers must be delicately molded into the shape of a bird about the height of a wild turkey, but more slender.

Before releasing the creation to travel through air and sky like a patch of flame, one should add a droll head from which extends a grotesque spoon-shaped beak (page 645). These components blended, there emerges the roseate spoonbill (*Ajaia ajaja*), found today in secret abundance along the Gulf littoral of Texas, and in more scattered rarity in Louisiana and Florida.

Lost in Quest of the Roseate Spoonbill

It was in quest of this incredible bird that John H. Baker, president of the National Audubon Society, two of its staff, George Burrows and Nick Scheannyder, and the writer found themselves on the evening of June 8, 1948, squirming on the horns of a real Texas dilemma.

We had set out from Houston early that morning, and by nightfall were west of Galveston. In the prescribed channel there was ample depth to accommodate the 20-inch draft of our Chris-Craft cruiser; but on either side were dangerous shoals and uncertain shallows. Dusk had fallen and was rapidly being replaced by darkness.

We were desperately seeking a chart-designated tributary channel which would lead us into deep and sheltered waters where we could safely anchor for the night. But we were unable to find the channel markers indicated on the chart. We dared not cast anchor in the main channel for fear of barge traffic, and we dared not venture out on either side for fear of shoals.

To make matters worse, the bulb in our overhead searchlight suddenly burned out.

Finally a small schooner came within call. We hailed it. With native skipper and family aboard, this outfit should certainly know these waters.

"Where's the channel into the harbor?" we called, to be answered immediately by a confident "Follow us."

Gratefully we fell behind, and in the now-sullen darkness inched along, careful to follow every turn of the schooner. Still no harbor. At last the skipper of the schooner announced, "I'm lost."

At this embarrassing moment the lights of a shrimper hove into view, coming from the opposite direction. The schooner was soon hailing it, and we could hear voices raised in the darkness. Shortly the schooner—and we in turn—were following the shrimper; but before long the leader of this nighttime parade came to a halt.

"We're lost, too," the shrimper captain shouted to his followers.

Said the skipper of the schooner, "We're anchoring here till morning."

With similarly abrupt and impatient finality, Scheannyder, our pilot, made for the nearest buoy and anchored alongside. Bars to the left of us, shoals to the right! Invoking heaven for salvation from barges, we turned uneasily into our bunks.

Good Luck Follows Bad

Such was the beginning of our spoonbill adventure, but with the episode of our first night out we had apparently used up our full quota of bad luck. Beginning next morning, and in succeeding days, the expedition moved with the smoothness of a Hollywood script.

My compulsion on this trip was to see the fabulous spoonbill in its natural habitat. The Audubon people were out to survey the efficacy of their sanctuary system for water birds of the Gulf coast. As of 1948, how were the birds withstanding the oil operations, the canal dredgings, the fishing for too much by too many? Was the maintenance of guardian wardens at island hide-outs during the breeding and hatching season paying conservation dividends?

Earlier that first day we had drawn up a quarter of a mile off Vingt-une Islands, which, quiet and low, lie in the tawny waters of bis-

toric Galveston Bay, less than 40 miles from Houston's towering skyscrapers and metropolitan bustle.

We were peering through our binoculars when the vegetation suddenly burst into pink flame as a mass of spoonbills left their foliage-hidden nests and erupted into the sky.

The initial burst of spoonbills was quickly diluted by the joining in of vast numbers of other bird species which were circling the shoal. Heightening the contrast of the spoonbills' roseate color were multitudes of snow-white egrets, black-and-white ibis, skimmers, and several species of slate-hued herons.

Perhaps sensing that we had come as friends rather than foes, most of the birds soon settled and disappeared into the shrubbery. Others not so trusting glided down on distant but still visible shallows, where, alert and anxious, they watched and waited. Folding its wings on landing, each spoonbill seemed to draw a candle snuffer over itself and dim its brilliant flame.

With skilled speed the Audubon observers studied every move through their glasses, counting and recording the number of adults and the number of immatures. From such figures would result fairly accurate estimates of the avian population, the probable number of nests, and the season's rate of reproduction.

Species Coming Back from Near Extinction

Here on this island, not far off the shores of Galveston Bay, we had seen evidence of the miraculous rehabilitation from virtual extinction of one of America's most glamorous birds.

This fact was made more dramatic by other sights down the bay. Dozens of oil rigs dotted the distant horizon, and several derricks stood there geared for active drilling. Gas vents from some of the wells burned with a color only weakly competitive with that of the spoonbills. Both avian and oil activities seemed to proceed without undue concern.

As long as the drillers do not pollute the bay with oil and salt waste, as long as their personnel does not trespass on or too near the bird islands, as long as there is no shooting, the spoonbills pay little attention to men reaching below the surface of the water for black treasure.

But let any of these conditions be violated and the spoonbills will quickly abandon nests, eggs, and young. All they demand is privacy for their communal activities.

An effective truce between man and bird did not always exist. There is evidence that before 1850 the whole coastal area from the Rio Grande to Florida was alive with untold thousands of flocking spoonbills.

The great encounter developed as American civilization commenced its southwestward march. It is perhaps understandable why, with their own physical survival at stake, the pioneer and early settler shot for needed food any bird that came within gunsight.

Later, even though the need for such food had long since vanished, slaughter of birds increased, stimulated mainly by demand for plumage. By 1900 the spoonbill had become an American rarity. There were no known breeding colonies in Texas in 1919, virtually none in Florida. However, in the remote lagoons of Mexico and Cuba the spoonbill clung to life. Occasionally a few members of the declining species would venture back to the islands of the Gulf coast and attempt nesting, but with little success.

Audubon Society Sanctuaries Successful

Beginning in 1931, and extensively since 1936, several island groups along the Texas coast known to harbor spoonbills were set aside by the National Audubon Society as sanctuaries and thoroughly patrolled during the nesting months of March through August. [illegible] the population of the Texas littoral had miraculously jumped to thousands.

As a result of direct educational efforts people living in the neighborhood of the im- [illegible] birds. Oil companies became increasingly aware of the good-will value of wildlife conservation in their drilling areas. Local nature groups became active in promoting bird protection for both economic and esthetic reasons.

The principle of truce was practicable; and the roseate spoonbill was saved to adorn Texas skies, saved to help maintain the biological balance between air and water fauna.

Our cruiser lay only a few hours off the Vingtune Islands in Galveston Bay. We did not go ashore, for nothing can be more disastrous than the blistering heat of noonday, which beats down on eggs and young when parent birds are frightened from their nests and into flight.

Swinging the bow of our boat southward, we proceeded down the bay, past Texas City, through Galveston Harbor. It was west of Galveston that our charts had proved unavailing and we had spent the night hardly anchored by a buoy. But next morning bright and early we were off again, speeding southwestward on the Intracoastal Waterway. Our intention was to visit, or at least to reconnoiter, every principal bird island along the coast from Galveston to Laguna Madre, south of Corpus Christi, an area teeming with all manner of water birds.

Roseate Spoonbills Are Black with Gorgeous Plumage and Long Curved Spoon-Like Crested Bills

Baby Spectacled Flycatcher Jumps Down Its Parent's Throat To Get Its Breakfast

From Splashed Egg and Awkward Nestling the Spoonbill Grows Up to Be a Dense Brunette

Atop Island Trees above Their Breeding Mates, Two Spoonbills Keep Lookout, Ready To Take a Turn at the Nest or Go in Search of Food

Spread Pinions Reveal the Rich Colors of Spoonbill Under Feathers

Only During Breeding Season Do Spoonbills Assemble in Large Groups

The Top Photograph [illegible] Spoonbills [illegible] Large Groups [illegible] Photographs [illegible] Spoonbills [illegible] Breeding Season [illegible]

[illegible]

Nesting Side by Side with the Spoonbills Are Egrets, White Ibises, and Other Water Birds

[illegible]

Scientists Leap Down Hurriedly upon Their Discovered Nests

A White Ibis Contemplates a Handsome Neighbor Roosting Peacefully

In the days that followed we found islands white with egrets, others covered with lumbering brown pelicans, some alive with skimmers, gulls, and terns. But the islands to stir one's avian dreams we found in what is known as the Second Chain, separating Mesquite and San Antonio Bays. It was on this Second Chain of Islands that some years earlier Robert Porter Allen had made many of his now-classic observations on the biology of the spoonbill.

It was over these islands, relatively remote from human visitation, that James J. Carroll, late of Houston, willed that his ashes be dropped from a plane. Carroll was among the first Texans to realize the danger of the spoonbill's extinction and the importance of its protection. His interest in conservation led to the naming and establishment of Carroll Island as one of Texas's great bird sanctuaries. The island, happily isolated, and alive with a fantasy of breeding birds, is today a dynamic monument to a distinguished conservationist.

Breeding Place of the White Pelican

Again we did not tarry long. There were many more islands to visit, long distances to travel. In succeeding days we went as far south as South Bird Island in Laguna Madre, the only breeding locale of the stately white pelican in the southern United States. We did not stop even there for more than half a day before turning northward again.

It was in the midst of wild Buccaneer Days celebrations that we docked at Corpus Christi. After many days of sloshing about in marshes or plodding on barren wastes, a reassociation with urban life and the experience of a fresh-water shower were welcome [illegible].

Here, too, the formal aspects of the expedition were scheduled to conclude. My Audubon companions were due at their Kerrville, Texas, nature camp. But for me the expedition was just beginning. My plans called for a revisit to both the Vingtune and Second Chain of Islands, and with the able assistance of Andrew Nowak, a more careful and intimate study of the spoonbills there.

After one refreshing day at Corpus Christi, we proceeded north by car as far as Tivoli, then to Hopper's Landing where rendezvous was made with the late P. O. Davenport, Aransas warden. Aboard the Audubon Society's converted shrimper, the *Pelican* (page 653), and, in company with Mr. and Mrs. Davenport and their son, we were soon chugging out into the bay, heading again for the Second Chain of Islands.

We passed the night hauled up alongside a mud bank just east of the great Aransas National Wildlife Refuge of the Federal Government. Here 47,261 acres are managed by the Fish and Wildlife Service of the U. S. Department of the Interior serve as a haven for wintering ducks and geese, for the few surviving whooping cranes, one of the rarest of North American birds, and for resident deer and turkeys.

From aboard our boat that evening, lying somewhere between the Aransas marshes on the mainland and the islands out in the bay, we watched an almost continuous stream of spoonbills, egrets, cormorants, ibis, etc., swiftly and quietly making their way from the feeding grounds of the refuge back to their island homes.

Next day we proceeded to Carroll Island. As we waded ashore from where the skiff was grounded, I was momentarily less aware of the clouds of birds flying overhead than of the words of mainland natives who had warned me to be wary of rattlesnakes. There was the caution that rattlesnakes, during a good blow, are washed in large numbers off more barren cays and onto the foliaged bird islands.

It was explained, to add to my comfort, that rattlesnakes, after being so dislodged, swim majestically forward, head above the surface like a periscope, looking for the nearest shore onto which to slither. But despite such unpleasant recollections, I quickly concluded that snakes would not have a chance on any island occupied by aggressive and sharp-beaked herons and egrets!

Birds Little Frightened by Visitors

Many of the spoonbills left their nests as we splashed ashore and, like those of the Vingtune Islands, settled in adjacent shallows. Slowly we walked around the periphery of the shoal, which was about 200 yards long and 50 across, tapering sharply at one end. At maximum altitude the island was not more than four or five feet above water level. The egrets, being less numerous than the spoonbills, had not risen in flight; instead, their long serpent-like necks stood erect and snowy all over the island, like pickets of a white fence (page 649).

Along the shore, hard by the water's edge, great numbers of young white ibis watched in frozen attention. From a distance it was not easy to recognize them as ibis, for in the adolescent stage this species is dusky, contrasting sharply with the white adult. These young were old enough to have left their nests and were sitting or standing on the shore, apparently feeding on whatever they

could find in the gentle lapping waters.

As we approached, they eddied noisily into the air, followed instantly by such adults as were still brooding on near-by nests; soon ibisian multitudes were riotously circling above. The portion of the island occupied by the white ibis seemed to be delimited from that occupied by the spoonbills, although egrets and herons were mixed among them all.

Second only to the spoonbills, the white ibis impressed me as the most spectacular birds on the island, especially when in full flight. With long, red down-curved beaks thrust forward, the brilliant whiteness of a flying ibis is broken only by the flickering of black-feathered wing tips.

Their nests were deep in ground brush and tules, and we were scarcely aware of their tremendous number until, as we approached, they stormed up en masse like great coveys of mountain quail. Reddish egrets also joined the flying squadrons, followed almost immediately by several hundred skimmers. These last, terrlike, were nesting in a myriad of little sand depressions on an exposed shoulder of the island.

By this time we had reached the far end of the sboal. We turned and, crouching motionless half out of view, studied the activities of the spoonbills which had settled in the shallows. One by one they began to return to their respective nests.

Landing of a Spoonbill a Marvel of Grace

If the take-off of a spoonbill is an act of beauty, one is all but wordless in describing the reverse picture. With up-tipped wings revealing the intense pink of body and underwing feathers, the female catches hold of branch structures above the nest; then flaps and flutters for a time until balance is attained (page 647).

If the wind is considerable, she must constantly readjust her position, using her graceful pinions to balance, much as the tightrope walker does his pole. Finally, after looking about a bit to be sure the environment is secure, she steps and flutters down to her nest and, lowering herself upon eggs or young, disappears from view.

Courtship in this colorful species begins in early spring and is almost as exotic as the bird's appearance itself. Spoonbills returning from a winter of dispersion usually begin to congregate on specific islands in April.

During this preconnubial period one may observe some very interesting exhibitions of mass behavior. Sometimes a wading group, quite undisturbed by outside influences, will burst skyward in unison circle for a while, and then settle again (page 646). Sometimes all the individuals of a wading group, again in seeming mechanical unison, will point their beaks skyward and gaze rigidly into space for long periods. When the hypnosis suddenly breaks, the birds lower their heads and proceed with normal feeding activities.

It is during this period of odd mass behavior that pairing occurs, accompanied by [illegible] male and female are almost identical in external appearance; it is only by their actions that the observer may distinguish between them.

Mating Follows a Period of Coquetting

When the crucial period of her physiological development has arrived, the female finds a perch in some area of the island suitable for nest building. She establishes herself securely atop a bush in the chosen nest area. Then by vigorously shaking twigs held tightly between her mandibles she announces to interested parties that she is approaching connubial [illegible]

An equally susceptible male responds by flying excitedly at her and trying with much wing flutter to get a foothold close to her, the while plunging his head in an odd jerking movement. If the female does not beat him away from her perch, betrothal is established.

After this episode the two birds keep constant company, and often may stand in strange quietude side by side with heads buried in back feathers. Soon nest construction begins; the male brings in twigs, and the female fabricates them into a nest wheel. If during this period an interloping male approaches the female or tries to interrupt nest-building activities, he is summarily driven off by the spouse.

As nest building nears completion, the male becomes more amorous in his behavior toward the female; but for a time yet she may resist his advances. Finally, on some instinctual impulse, she perches herself on the nest with a strong twig grasped in her mouth.

As she crouches, the male seizes the same twig from behind, and they both hold on to it. At length the twig is dropped, and the male clamps on to the narrow part of the female's beak with his mandibles. Mating then occurs, and is repeated during ensuing days.

Eggs begin to appear in the nest within a week. The male and female alternate in brooding, and after an incubation period of about 23 days the young—usually two or three to the nest—are hatched.

Naked little pink creatures at first, the

Ruby Roseate Spoonbills Belie Their Name: They're White, Not Pink

[illegible] hot and hungry three week-old spoonbills on one of the Second Chain of [illegible] huddled in a nest of twigs only a foot above ground. At this age young [illegible] of down which is not hues pink. The elaborate plumage of maturity is not [illegible] three years old.

young soon develop a fluffy white coat of down, which, as they begin sitting about the nest to test their leg and wing muscles, slowly becomes faintly pink (page 645).

A little later the youngsters venture about the nest [illegible] and [illegible] preliminary [illegible]. When the colony is disturbed and adults take flight, the young crawl deep into the brush to positions of relative safety.

During the [illegible] adults [illegible] food, mostly minnows, shrimp, prawns, [illegible] and regurgitated near-[illegible] (page 644).

[illegible] Singly or in small groups the birds scatter over the marshlands of the Gulf coast.

Three full molts over a period of as many years result at last in the magnificent plumage of adulthood. A dripping epaulet of crimson has developed on each shoulder, tail feathers are splashed with yellow and orange. The rest of the plumage displays more delicate hues of pink. Adults molt partially both [illegible] than the older ones.

In the [illegible] crest the adults [illegible] with the less colorful non-breeding adults [illegible] Galveston and San Antonio Bays.

Protection Being Reduced Rapidly

Although it may seem that in Texas the principle of maintaining guard over the spoonbill [illegible] For example, one hears voices raised by local bird-minded Texans against oil pollution of the lagoon waters.

Passing within a few miles of the bird is-

Cruising Along the Texas Coast He Spots Spoonbills in San Antonio Bay

[illegible]

[illegible] Coastal Waterway, a dredged [illegible] mainly by oil barges which are pushed by powerful tugs from oil-fi[illegible] [illegible], but so often the bilge water [illegible] pumped from the bottoms of [illegible] If this is done in the open, the petroleum scum is washed ashore to blacken white beaches; some sinks and in time sinks to the shallow bottom. Thus, surface, bottom, and shore creatures alike suffer—and consequently the birds that depend on the organisms for food also suffer.

In fairness to the oil interests, it must be said that most companies have seen the long-range folly of such pollution and have taken independent action to correct the situation.

Other threats to the spoonbill fall into the [illegible] natural hazards—parasites, storms, [illegible] weather, etc. But [illegible] spoonbill seems to have been adequately equipped by Nature. It is man-made [illegible] against which the spoonbill has little [illegible]. Against these the conservationists have directed their principal energies, and with remarkable success.

[illegible] in Florida is another [illegible] contributing immature spoonbills visit Florida each spring and [illegible] few adult birds [illegible] mature visitors [illegible] probably Cuba or other Caribbean islands.

Through the years the National Audubon Society, in collaboration with the [illegible] Wildlife Service, has manned the [illegible] sites of the roseate spoonbill in Florida Bay. Although the number of nests has increased somewhat, the total still remains far from satisfactory.

In Texas, however, for the moment all seems to be well with the pink [illegible]. We did not stay on the Islands longer than necessary to make our observations and take photographs. We left with the hope that we could tell an adequate story of how Texas's [illegible] had been snatched from the brink of extinction by the simple formula of seeing to it that during the breeding season the roseate spoonbill is accorded a reasonable degree of privacy.

Jungle Journey to the World's Highest Waterfall

By Ruth Robertson

With Illustrations from Photographs by the Author

Still [illegible] a mile high in the jungle fastnesses of eastern Venezuela is Angel Falls, world's highest waterfall, 15 times higher than Niagara Falls or, by another yardstick, more than twice the height of the Empire State Building. Its first drop is 2,648 feet; its total 3,212.

I saw it the first time from the co-pilot's seat of an old unconverted C-47 just two years ago as we flew over this weirdly beautiful high jungle between the Orinoco and Amazon Rivers.* On that flight to Auyán-tepui, so-called Devil Mountain, I shot more than a dozen Kodachromes in the vaulted Angel Falls canyon.

As we flew over the dense jungle floor of the canyon, I resolved someday to enter that canyon valley on foot to get photographs from the base of Angel Falls and to determine its exact height.

A "Lost World"

From almost impenetrable jungle rear massive like mighty fortresses a mile to two miles high, their sides and flat tops eroded into queer shapes.

This part of Venezuela suggests the setting of Sir Arthur Conan Doyle's *Lost World*, of W. H. Hudson's *Green Mansions*, of L. R. Dennison's *Devil Mountain*, and some of those tag names still stick to the area. But Venezuelans and the pilots who fly south of the Orinoco on their jungle runs call it simply the Gran Sabana—great high jungle plains.

Auyán-tepui has been scaled from the south side by the veteran explorer and ornithologist, William H. Phelps, a Caracas businessman, and by his skilled son, Billy Phelps, Jr. Others who have reached the top were members of an expedition from the American Museum of Natural History, New York, and a few hardy Indians.

The aviator Jimmy Angel (page 657) and his wife, Marie, and Gustave Heny crash-landed in the boulder-strewn swamp on the mesa top in 1937. None, however, reached Angel Falls from the top or through the Churun canyon almost a mile below.

Thousands of years of erosion have dug out huge crevices and fissures over the flat surface of the giant mesa of Auyán-tepui, making it impossible to travel far. These deep crevices serve as a catchall for heavy rain.

At one point this water bursts out a few feet below the canyon rim into a waterfall of such proportions that it is no wonder Jimmy Angel was astounded when he first saw the falls which now bear his name. That was in 1935.

Not until the autumn of 1948 was the problem of how to get into the canyon solved. I met Alejandro Laime, a Latvian who had been roving around the Gran Sabana for several years. He offered to act as guide to the falls.

Later a talk with bush pilot Sam Foles brought the suggestion that Laime take Indians into the jungle to the north end of the giant mountain and clear one of the little savannas near here as a suitable landing place for a small plane. In that way, we hoped, we could cut out several weeks of going by *curiara* (dugout) on the rapids-strewn rivers and days of hacking through jungle with machetes.

A DC-3 could take us into Kavayen at the south end of Auyán-tepui, and we could then be shuttled, one or two at a time, to the prepared airstrip. There Laime and the Indians could be waiting for us with enough curiaras to take us into the canyon and to the falls.

Laime went back into the jungle, and this spring we sent him word to get the airstrip out. April 24, 1949, was set as the date of take-off from Caracas.

Hectic Last Days

The last few days were hectic. There were last-minute conferences with the Venezuelan Government's Minister of Communications about the radio and radio man going with us; there were purchases of cases of dehydrated foods and camping equipment. There was the assembling of waterproof bag, jungle hammocks, snakebite kits, first aid kits, compasses, machetes, rope, ammunition and guns, flashlights—a hundred other things.

* See, in the National Geographic Magazine: "Caracas, Crucible of the Liberator," by Luis Marden, April, 1943; "I Kept House in a Jungle," by Anne Rooney Lindsey, January, 1944; "Journey by Launch Fifteen to Be Home on the Crest of the Rock," November, 1944; and "In Humboldt's Wake," November, 1947. Later articles include "Through Hazard to the Summit of Mount Roraima," by G. H. H. Tate, November, 1949.

Looking a Hair Stretch Is Never Done in Bogota, Near

[illegible] a ready sense of humor. This old fellow made a fetching [illegible] of the [illegible] [illegible] as it may be, the face of the person he most admires. The [illegible] of South America is honored [illegible]

[illegible] the [illegible] [illegible] mirrors [illegible] each [illegible]

The Take-off from Chaparé

Lt. Col. [illegible] U. S. Finney [illegible] take-off [illegible]

[illegible] big red truck which had been backed [illegible] right before with every [illegible] gear [illegible]

[illegible] Valley [illegible] natural [illegible] with rusty [illegible]

[illegible] its silver path across the [illegible] landscape were from [illegible]

[illegible] hopped down to the [illegible] Valley [illegible] natural [illegible] with rusty [illegible]

Pulled to one side as a little [illegible] team Cub Cruiser Our pilot, John [illegible] Olson, red-bearded spelunker, was waiting.

After a conference [illegible] from this south [illegible] north side [illegible] April and we knew they must be running short of food.

The rest of us sat under the wing of our plane and ate h[illegible] [illegible] wh[illegible] [illegible] quiet valley. We made [illegible] comfortable for what we [illegible] [illegible]

Jimmy Angel Gave His Name to Angel Falls

[illegible]

[illegible] Black flies which at[illegible]

[illegible] surveyor did not [illegible] [illegible] the airstrip and to return [illegible] read the note, stood up in the [illegible] the [illegible] appeared!

[illegible] the Indians [illegible] who [illegible] Spanish [illegible] Indian

The Author's Dugout Was Small, Tippy, and Leaky, but Fast

[illegible]

[illegible]

[illegible]

An Indian Fishing Picnic

Lenie and I gathered up our cameras, [illegible]

[illegible]

[illegible]

While the fishing [illegible]

[illegible]

Map © Rand McNally & Co.

How to Jungle Pilgrimage of Eastern Venezuela Reaches the World's Highest Waterfall

This wild area south of the Orinoco River may be reached by [illegible] to the natural airstrip of U[illegible] but the trip from there over and to the entrance on the north side of Auyán [illegible] I author and her party were the first eight [illegible] from outside to accomplish the feat (page 655).

The radio was repaired, Perry Lowrey, the engineer, had arrived, and the airstrip had been located by our scout plane.

Flight to the New Airstrip Abandoned

But hopes were dashed soon after breakfast, however, when we looked toward the [illegible] toward us! He and his Indians had paddled in during the night. Lacking any further message from us, they had taken it for granted we had turned back.

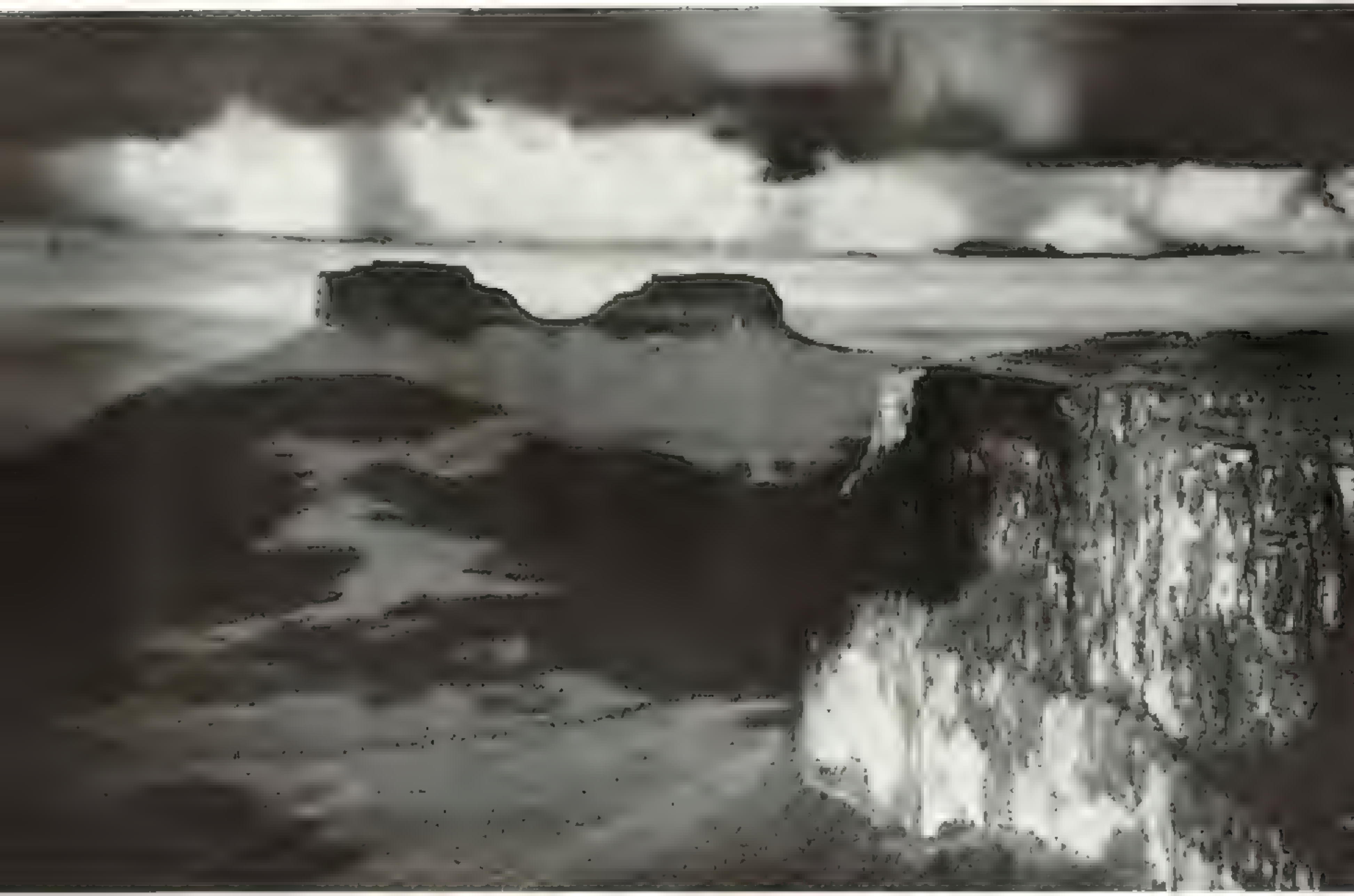
There was no advantage now in our shuttling up to the new airstrip for the Indians would have to paddle on back. After a long powwow we decided to scrap the idea of using the advanced airstrip, and to go along with the Indians, provided Laime could induce Aleio Calcaña, their chief, to let them make another trip to the gorge.

Frank Knee took our newcomer, the surveyor (pages 657, 654, and 660), down to our swimming hole for a dip before dinner. Gomez made contact with Ciudad Bolívar and with Santa Elena and told them we would soon be on the move (page 653).

Next morning we packed early, expecting the Indians, but they didn't show up. Laime came back alone from the chief's camp later in the day and told us there was a celebration

[illegible] Lindsborg's Water Street Washes Tumbles More than Half a Mile [illegible] Falls in the Heart of Ausmus-[illegible]

[illegible]



under way for the returning Indians and we would just have to wait it out. We were irked at the delay, but there was nothing we could do.

Over the evening campfire Laime told us about dangers we might encounter on our journey. He cautioned us against getting up at night without first flashing a light on the ground. In the jungle, he said, there were huge tarantulas and an occasional snake. He had seen many hills of *sabanamera*, large ants, the sting of which causes a 24-hour fever.

On the savannas, he said, there were many tapirs, deer, and other small animals, and he had seen one jaguar. The Indians had reported finding remains of pigs another jaguar had eaten.

Digging Out Fleas

As Laime sat doubled up by our campfire, he was digging out of his feet *nigua*, small burrowing fleas, the females of which have imbedded themselves deep in calloused spots. He first took a razor blade to make an X over the spot; then, with a sharp-pointed stick, he worked around the flea and its attendant egg sack and deftly lifted them out.

Not until noon Tuesday did we get away from Urayén and start the 10-mile hike toward San Rafael de Acanán, on the Acanán River. The Indians came early in the morning with their families, but simply sat around camp without showing any intention of moving.

Finally, around noon, they got up, packed everything in their backpacks and started down the trail that led to the jungle. Helping me carry my cameras and equipment was a 9-year-old boy, Jacinto.

The trail led through jungle and savannas. I didn't think we could make it to the Río Acanán in one afternoon, but we nearly did. The savannas had many little grass orchids of blue, purple, and pink, and everywhere were little white star grass flowers. At three of the rivers we crossed we paused for five-minute rests (page 671).

At nine dusk we walked into the kitchen of the chief of the Camaracotos, Alejo Calcaño, where the fiesta for the returning Indians was still going on (page 656).

Near the river's edge was a large grass-covered square shack, open all around, and large enough to accommodate us all. It was dark by the time we reached there. Our bearers straggled in, one by one.

Since our Indians were not able to bring all our gear in one load, we had to wait at San Rafael de Acanán another day while they went back to Urayén for the rest.

The next morning we were all up by 5. Now all our gear had to be repacked into the four dugouts on the rocks below San Rafael de Acanán. We helped carry the equipment down, for we were impatient to be on the river and on our way.

Most of the women and children of the Indians going with us had come down to see us off. They gave us pineapples and green bananas, and we gave them combs, towels, anything we could spare, in return. I was happy to see that old Raya, an Indian elder, and little Jacinto were going along with us.

Alejo Calcaño also permitted an Indian woman to go along. She was Juanita, wife of a 16-year-old Indian in our crew (page 656). Sidas told us she had had three husbands before this one.

The dugouts were filled to the brim with our equipment, cartons of food, canteens, fresh pineapples, bananas, insect repellent, cameras, bows and arrows, fishing tackle, and huge rounds of cassava bread. Besides that, the Indians brought several chunks of fried pork tied on strings and hung over the sides.

At last we stepped gingerly into what small space was left for us, and shoved off the rocks. There were abortive good-byes and hand-waving until we turned a bend in the Acanán.

We were finally on our way to Angel Falls—not the way we planned to go, but definitely better—in the right direction, and moving. There were five of us and ten of the Indians—15 in all, counting little Jacinto.

It was wonderful to be on the river. The water was cool and black-looking, and the klug-klug of the paddles as they hit the sides of the dugouts was somehow cheerful.

Late in the afternoon we were thrilled to hear a DC-3 heading down the river on the lookout for us. It was a TACA plane piloted, we knew, by either Capt. Art Jones or Capt. Charlie Bagphan. The plane made several passes over us, and I stood up in the dugout with arms overhead, prize-fighter fashion, and waved we were all right.

A Wet Night in a Stilted Hut

At 5:30 that afternoon we went ashore at a spot Laime and the Indians had chosen. Up the savanna from the river were several dirt huts belonging to a relative of one of our Indians. The occupants were not at home, and we decided to stay there overnight.

Rain began before we had finished our evening meal, and we dashed for the huts in a downpour. Some were badly infested with fleas, but fortunately the one I was in had none. The shack was stifingly hot, and I stood in the doorway for a long time to cool

A Plane's Seat from a Wrecked Plane Was the Pride of the Community Grass Hut

[illegible]

Indians Make Careful Preparations Before *Bamboo* Fishing

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Some Strange Insect Bedfellows

[illegible]

[illegible]

end of our tarpaulin shelter. By the light of the fire I caught up on my notes.

One nocturnal visitor was a beetle about an inch and a half long. Most interesting thing about him was his lighting system. He had two lights in front, much like automobile headlights, which shone ahead with a phosphorescent beam, illuminating a circle fully eight inches in diameter.

Since it was raining rather hard, I hung my hammock under the tarpaulin shelter. Ernie had his down by the river under a palm thatch. Perry, Laime, and Enrique went back to the Indians' hut on the trail.

The next morning was Saturday—two weeks since we had started out on the expedition—and we packed the dugouts in a steady rain. The Acanán was rising rapidly. Ernie had to maneuver a lot to get out of his hammock, because the river had risen several inches during the night and the shelter was inundated.

We changed into different dugouts before taking off, because both Ernie and I wanted more flexibility in our photographic work. Each of us got into one of the two smaller canoes.

Mine was a tricky little craft. When I rested my hands on the sides, my fingertips were in the water. We were certain to ship a few gallons while shooting rapids. I kept a gourd handy, and when the water sloshed around my ankles I knew it was time to bail (page 658).

Old Reva and Manuel, a quiet, shy boy, came in my dugout and we took off to get pictures of the rest as they came around the bend (page 670).

Within a few minutes we came to the Carrao, the river which winds and turns maddeningly but eventually flows past the entrance to the canyon of Auyán-tepuí.

An Indian "Rain, Rain, Go Away"

Old Reva had a habit of rain-chasing. He would nudge me, point to the rain cloud ahead, and proceed to make "ptu, ptu" sounds, tossing his head sideways on each "ptu." That was supposed to chase away the rain spirits. Once I got the idea, I joined in, and Reva roared with laughter.

One of our Indians, a magnificent physical specimen, intrigued Ernie and me. He was Rafael, the 18-year-old who had brought his wife along. Rafael wore nothing the whole trip but a red loincloth.

Juanita, his wife, probably about 25 years old, was squatty and unbeautiful, according to our standards, but efficient and certainly an authority on each stream, rapid, and mountain. She had a name for them all.

Juanita sometimes wore her hair in two braids, sometimes combed it out to flow over her shoulders; but the whole effect, photographically, was spoiled by the shapeless dresses which the Capuchin missionaries had persuaded the women to wear.

Some earlier explorers to this country had reported these women wore nothing except the strands of beads around their necks, ankles, and wrists, and a beaded G-string. I kept a sharp lookout and discovered they still wore the bead ensemble underneath.

The flowers and flowering vines on the Río Carrao grew more beautiful as we went along. There was one tree with waxlike blossoms that smelled like ginger lilies and perfumed the river for miles. Purple flowers hung everywhere. One vine had interesting sprays of red fronds like a tiger's tail.

Once we saw a group of "water dogs," or nutrias, cavorting in the stream ahead, unfortunately out of camera range. In the jungle we saw a long animal with bushy tail and yellowish head, probably a jaguarundi, or "otter cat."

Through jungle growth we began to see Uey-tepuí, the saddlelike double-peaked mountain we must circle before again coming to Auyán-tepuí (page 661). The heavy rainfall of the last few days had made waterfalls spring from every mountainside. The rapids got progressively more swift and dangerous, and we used up a lot of time in figuring how to get through them.

Nevertheless, we made excellent progress that day and successfully portaged around Cuai Rapids, a stretch of dangerous water. Even cautious Laime opined we might get to the entrance of the Río Churún the next day if we kept up our progress. Our spirits rose, for the Churún is the river which flows out of the canyon and leads to Angel Falls.

Having seen no planes that day, we concluded that the radio message of the night before had got around. We cooked a huge pot of spaghetti, dehydrated onions, garlic, and corned beef, Enrique's favorite dish, and sat around speculating on the distance yet to go. The Indians, in an adjacent hut, were really neighborly and passed us a platter of golden-fried plantains. We returned the favor by sending over a pan of spaghetti.

I turned in at 7, and for the first time took off my outer clothing. Usually it was quite cool by nightfall, so that an extra sweater, a windbreaker, and two blankets felt good over regular clothing.

This camp was not in a savanna but merely in a small clearing in the thick jungle, just

big enough for the tiny boats the Indians put up. There was no breeze in the jungle, and it was hot and sultry. The moon was half-full, and the soft light filtering down through the jungle growth was beautiful.

I was awakened in the night by a driving rain and by morning was sitting wet in my hammock. We ate quickly and got started in a light drizzle. I brushed my teeth on the way, washed my towel and socks, and stretched them on top of some broad leaves which covered my cameras as a waterproofing.

My legs and arms, even my face, were still lumpy and itchy from the sessions with the Uruyén *jejenes* (page 657). They hadn't bothered us much since we took to the river and they don't bite after sundown. The men, though, had a great deal of trouble with the fleas, and every evening they searched for them and for ticks.

At 8 we began the half-mile-long rapids and shot them with a lot of excitement but no spills. The rain stopped and the sky cleared somewhat so that we could see part of Uey-tepui almost over us. We had to stop and caulk my dugout, which was leaking badly.

Weird Sounds in the Land of Waterfalls

All day we heard unseen rapids and falls roaring like threshing trains. Now and then, through the clouds and the high trees on either side, we saw waterfalls gushing down the sides of Uey-tepui.

The sun came out in the middle of the day, and old Reya was happy about the sun. He nudged me, pointed to it and then to Uey-tepui, and said: "Mo-tsemo." Then I understood that Uey-tepui meant—Sun Mountain.

We rounded Uey-tepui and suddenly, in the distance, was the north side of Auyán-tepui, the colorful rock and sheer cliffs so familiar to me from the air. Reya began puffing in earnest now with his rain-chasing winds and chanting and frowning as he looked at Auyán-tepui. The Indians are superstitious about the Churún canyon we were so soon to enter, and also about Devil Mountain.

We saw a tapir in the afternoon, but it was swimming on the other side of the river. There were lots of bats, too, flying for short distances, then clinging upside down to trees hanging out over the river.

We had planned to stay overnight at a hut Laime had built when he and the Indians passed this way a month before on the trip to clear the savanna. But when we arrived at the hut, we had to leave in a hurry. The place was infested with fleas, and the boys were covered as they stepped ashore.

Downstream another half mile the Indians cut bushes and trees and made a new camp for us. They went back to stay at the old hut I think they actually liked to get fleas in their feet. It gave them something to do at nights around the campfire!

Our camp faced the northeast corner of Auyán-tepui, looking like a mysterious dark fortress in the moonlight. Ernie and Perry went for a ride in one of the dugouts and came back with a 7-pound fish which they said they caught themselves. Pinned down, however, they admitted they had been given to the Indian camp when the men came in from fishing.

The roaring of red howler monkeys awakened me at 5:30.* If there is anything noisier than the jungle, I haven't heard about it. I had slept soundly, though, once I had given up the search for an elusive bug in my hammock.

We took off early from our camp on the Río Carrao and half an hour later entered the Churún River and the wide mouth of the gorge, which would narrow down into the canyon leading to Angel Falls. It was Monday, May 9.

While Perry was frying fish for breakfast Enrique sent out messages that at last we were within sight of the entrance to the Churún and hoped to reach the gorge that day. After many days of rain, this morning began bright and sunny—a good omen, I thought. Our spirits, after days of enforced cheerfulness, were at high pitch, and we sang our favorite songs. The Indians seemed to enjoy hearing us sing.

Indians Wear Red Paint To Ward Off Evil

They had come from their camp with their faces painted with a deep-red paste, which they get in the jungle. On the paddles mysterious-looking signs were painted in the same red. The Indians were quiet and solemn, and small wonder. They had never been in this canyon, and the tales we had heard about the canyon and the evil spirits inhabiting the jungles there had made good campfire tales many a night as interpreted through Salas. The paste was to make them invisible to the spirits.

The beauty at the mouth of the Churún is a breath-taking sight. High jagged rims of Auyán-tepui were all around us. One point we named Judge Washington because of the definite Washington-like profile in the rocks along one particular rim.

I discovered this particular morning that I wasn't so immune to burrowing fleas as I had thought. I had developed itchy spots on the

* See "Monkey Folk," by William M. Mann, NATIONAL GEOGRAPHIC MAGAZINE, May, 1938.

Hole Hidden in a Niche of Devil Mountain Is Angel Falls, World's Highest Waterfall

[illegible]

Comanche Indians Watch the Cub Geyser Prepare To Take Off from the Natural Airstrip in Heaven Valley

Sidebar: Sabar Wife and Children Leader Candace Lide

Only From the Air May Angel Falls, World's Highest Cataract, Be Seen in Its Entirety

Because the Uruyen and Ayala Rivers Were Too Shallow for Boats, the Expedition Trekked from Uruyen to the Deepest Amazon

Under Nevamstepne, Hidden by Cacuds, the Party Breaks Camp at the Arroyo To Begin the Dense Hike to San Rafael de Nuevo

As the Arctic Winter Ends, an Indian Lad Draws a Head on a Big Fish

[illegible]

Women Sense Without Knives a Fish Fresh from the Water

[illegible]

Indian Visitors Usually Stayed in Camp from Dawn Until Bedtime

[illegible]

Oar and Paddle Are Spurned Red To Wood Off Evil Spirits. Mouse Flows Down the Canyon Toward Devil Mountain

The Largest Woodskin Canoe on the Rio Caroni: Carried Bolivar on Guayas and Little Jacinto, with Sabas and Pumata as Paddlers

Passing a Large Woodskin Through Wild Rapids Was Tricky Work

Often Four Indians Were Required To Hold the Canoe from Being Swept Away

Rainsford Garrez Directs Indians Transporting Equipment Across the Aisha — They Forded Some Streams, Crossed Across Others

Red-painted Indians Intro Tots to Grandparents Take Part in the Festival Party Pages 674 and 675

Through the Venezuelan Jungle Gleams Angel Falls, Still a Six-hour Climb Away

[illegible]

bottoms of my feet, and at the first stop Manuel found a twig from the right kind of bush, sharpened it, and dug out four of the pesky things.

We had to stop every few minutes along the Churún while Laime and the Indians reconnoitered to see if we could go farther by dugout. There were many shallow rapids to pole through. In the deeper stretches we all paddled like mad against the turbulent swift currents. When Manuel poled, I rested my paddle, wrote occasional notes, took a picture or two, changed film, tried clothing, or else [illegible] little dugout was very tippy and had developed a bad leak back on the Carrao. I dipped occasionally with the gourd.

Making rather good time, we soon passed the spot where Laime had stopped when he was in a month ago. We were fortunate that the rains had set in, making the Churún run higher. It was possible to go farther by dugout than we had [illegible]

Old Egypt [illegible] "pto, pto" sounds constantly. Manuel, in front of me, was openly fearful of the river. He had a bunch of herbs which he would hold aloft toward the sun, muttering a sort of chant. All the Indians were jittery about entering the canyon, but our group laughed and sang and yelled from dugout to dugout until the tension lessened.

By noon the Churún was running rapidly. It was all we could do to make any progress in its black, icy, foam-flecked water. Rivulets of perspiration were running down Manuel's brown back. We took off our shoes and rolled up our trousers, and when we came to shallow spots we got out and helped the dugouts through.

The banks were beginning to look mossy. There were many sand spots, and the sand was of a fine quality and rose beige in color. Leaves of the small shrubs and some of the trees had pink undersides. The trees leaning over the banks were heavily mossed. Grass grew in tufted, mushroom-shaped clumps, even in midstream.

Stripping Down for the Final Dash

By 2 p. m. we could go no farther up the Churún. The stream was too swift and shallow. We pitched camp on a high bank and sorted out our equipment and clothing, most of which was to be left at this camp. We would take only enough for the last dash to the falls and only what we could carry on the trail. The ten Indians would be heavily loaded, and we each planned a backpack of our own.

The radio equipment, so vital on this last unknown part of the trip, took three Indians alone. And Perry's surveying equipment, Ernie's movie cameras, and my own four cameras and boxes of film and bulbs were heavy and bulky. Besides, we had our food and camping equipment and several backpacks of cassava for the Indians.

We shook out everything that wasn't desperately needed, for we knew every ounce would count. We hoped to make the trip in to the falls and out in five or six days.

This camp, on a bend of the Churún directly north of the falls, was on an elevated spot above roaring rapids. Everything we weren't taking was placed under shelter of our little palm-covered hut.

While the Indians were building it in the afternoon the cry "Cobra!" (snake) went up. However, nothing seemed to come of it. There was a tapir near by when we first arrived at the campsite, but he disappeared down the bank.

During the camp building, little Jacinto came to me with a deep machete gash in one of his fingers. I filled the wound with sulfathiazole cream and bound it tightly.

Our campfire conversation that night consisted mostly of speculation on the length of [illegible] take two days to get in, depending upon ourselves and how fast we could make the trail. We all agreed we would need about two days there—Perry for his calculations on the height of the falls, Ernie to take movies, and I to shoot stills. Then two days out—a total of six days. We packed food for six days, no more. If it took longer, we planned to send Indians out for more supplies.

The Indians were fussy the next morning about the load. Everything had to be repacked until they were finally satisfied. After a heavy rain during the night, we did not look forward to the walk through the jungle. This was the unknown part.

At noon we stopped in the shelter of huge rocks in a deep ravine where ice-cold water tumbled down over deadfall and rocks with the roar of a locomotive. We were wet and weary after the morning's trek.

We had plodded hours on the trail through a drizzle, and the rains of the last few days had made swamps of savannas, quagmires of soft leaf mold. The green, mossy rocks and logs were treacherously slick.

Strong vines caught at our feet and tripped us mercilessly. Trees which we reached out to grasp to regain our balance disintegrated in our hands; they had been dead for years. But could not fall because of the jungle vines

Jungle Sleeping Hammocks Were Snug and Cozy

[illegible]

and other thick growth which held them in their place.

We [illegible] [illegible] [illegible] dropped cassava bread in the stream to soften it, and we could [illegible] [illegible] it. [illegible] the men [illegible] [illegible] [illegible] [illegible] cassava [illegible] [illegible] [illegible] [illegible]. I [illegible] said the Indians could go farther on cassava [illegible] [illegible] [illegible]. Sugar [illegible] [illegible] [illegible].

After the first [illegible] on the trail I was [illegible] [illegible] [illegible] [illegible] in the supper setting, but [illegible] [illegible] [illegible] up under the [illegible] [illegible] [illegible].

[illegible] had made contact with [illegible] [illegible] [illegible] [illegible] [illegible] two days. [illegible] [illegible] well. We were all well, things were going [illegible], and we didn't want [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] we were [illegible] for [illegible].

It is dangerous living in this area in [illegible] weather and I get jittery when I hear an airplane overhead looking for us in the kind of weather we have had the last few days. [illegible] [illegible] [illegible] [illegible] narrow.

We heard a small plane in the [illegible] [illegible] the morning. It seemed to be following the [illegible] up the gorge, but as the [illegible] [illegible] [illegible] [illegible] [illegible] from the [illegible] [illegible] in the [illegible]. [illegible] the plane [illegible] [illegible] the [illegible] the jungle [illegible] [illegible] [illegible] couldn't see the [illegible].

Slow Progress on the Trail

The second day on the trail [illegible] [illegible] [illegible]. [illegible] I [illegible] [illegible] [illegible] [illegible] [illegible]. The [illegible] [illegible] [illegible], and the sun [illegible] through the [illegible] [illegible] [illegible] was necessary. I [illegible] [illegible] [illegible] I had to stop [illegible] [illegible].

We crossed [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible]. The water [illegible] [illegible] [illegible] and a little [illegible], but [illegible] [illegible] of a rest [illegible] along the trail [illegible] [illegible] have tasted better.

Our [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

As Gomez Receives a Message, Rufino Is Ready To Turn the Generator for a Reply

[illegible]

[illegible] Lucas jeered [illegible] and I [illegible] some energy from it.

Lucas was getting discouraged [illegible] progress. He himself was a human dynamo. His energy [illegible] the end of [illegible]

We knew that we were getting close to our goal [illegible] walls on both [illegible] were narrowing. And then, in a clearing, I [illegible] I recognized from the aerial photographs I had taken of the falls.

In distance it couldn't have been very far, but [illegible] slowly [illegible] the way [illegible] fall and [illegible] Lucas and I [illegible] private [illegible] distance [illegible] this canyon [illegible] would be [illegible]

The World's Highest Falls Sighted

And then, just when it seemed I could not go another step, a shout went up ahead. The first view of the falls!

We [illegible] what [illegible] We [illegible] view [illegible] east side, and an outcropping of rock hid the lower part from view. Nevertheless the sight was stunning.

Now we knew we could actually get there. We were all for going closer, but Luis's words [illegible] us to make camp and scout ahead the next day to see if there was a better place for the [illegible]

Lucas [illegible] the rest of that afternoon. It was [illegible] wonderful to walk [illegible] of the Churún and stare [illegible] at the [illegible] so different from the [illegible] views I had [illegible] plane.

The Indians set to work making another hut for the night. [illegible] sound, the ringing of their machetes, the [illegible] cut down [illegible] and other big leaves for a roof. Soon we would have a [illegible] I was stiff and sore from [illegible] long trip. Moreover, I was [illegible] and [illegible] shoes and [illegible]

[illegible] our Indians [illegible] nothing but a [illegible] We [illegible] with a [illegible] the bottom of his [illegible] I put some cream in the wound and

"The Old Swimmin' Hole" Attracts Naked Urchins near the Big Chief's Hut

The Indians Keep the Ground Outside Their Grass Houses Neat and Tidy

Perry taped it tightly. The Indian woman, too, came with smaller cuts on her bare feet, and we gave her the same treatment.

For all our weariness we stayed up late that night. We took our cups of tea from the campfire and went to sit on rocks by the water. As if on cue, an orange full moon came up about 7 and turned the dark mass of the canyon wall into half-light, with the falls a shimmering silver streak down the middle.

Whatever hardships we had endured on the trip this particular moment seemed to make worth while. Perry said we were about two miles away from the falls. Enrique sent out our message that night telling those who were listening that we were in sight of our goal.

It was noon on May 12 when I finally climbed the last rock of the promontory in front of the base of Angel Falls.

For hours we had been struggling over tremendous rocks which had fallen off the top, almost a mile above us. We could hear the roar of the falls, but could see nothing because of the jungle growth.

Finally, around 11, I caught a glimpse of the top of the falls pouring off near the sun. I plunged into the dense growth again and climbed upward in that direction.

A Box Seat for Nature's Master Spectacle

The rock promontory in front of the base of the falls seemed to be made solely to observe the magnificent spectacle before us.

Plunging through jagged rocks a few feet below the canyon rim more than half a mile in the first unbroken drop roared the falls. They deafened every other sound, and whirled in spirals as the wind caught them and sent them out over the valley below. Often they swirled out to the rocks we were sitting on and drenched us (pages 660, 667, 670-671, and 682).

Behind the waterfall is a tremendous amphitheater, providing a spectacle beyond description. So far as I can learn, we were the first to see this sight from the promontory.

The rocks overlooked not only the falls but the whole valley up which we had come. We could see the deeper green winding line of the Churun and even the rocky little beach about two miles back where we had made our camp.

After one quick look Perry hurried off to begin the big job of measuring the falls. Laime disappeared to help Perry in finding spots for the base line. I sat fascinated on the rock.

Old Reyes sat cross-legged near by, his impassive face bent over a reed mat he was making for me.

Before we had taken off from camp that morning, the Indians had come to me all painted with red paste. They brought a small piece of it and a mirror over to me and asked if I would also "make myself invisible to the spirits." Obligingly I had painted circles and dashes over my face.

Finally we took leave of our box seat and headed down in another direction to explore the secondary falls and the small river which joins them to the Churun.

We sent out a special message that night on the transmitter. "Saludos" to Col. Jorge Marcano, then Minister of Communications who had been so helpful in this venture; to Col. Frank Bender, who had flown us into Cuyen at the beginning of the trip, to Captains Charlie Baughan, Art Jones, Sam Fales, and John Olson, all of whom had contributed to the success of the expedition.

"Anybody superstitious?" Perry wrote to know the next morning. It was Friday, May 13. [illegible] to cut a base line for his chain tape.

Since it looked too rainy for pictures when they took off, I dawdled around camp, luxuriating in the realization that we had achieved our goal. With that achievement there had come a letdown and, after breakfast, for the first time I went back to my hammock for another couple of hours.

Friday the 13th Fairly Quiet

Friday the 13th brought only two untoward incidents. A large singing ant climbed on one of my socks, but I got it off without getting bitten. At noon, a huge tarantula crawled to within striking distance of Enrique as he sat on the ground eating.

Laime and I saw the horrid thing at the same time as it came out of the jungle and headed rapidly toward Enrique, but Laime was quicker and yelled for Enrique to get up. Enrique literally rose from the ground in one swoop, never spilling a drop of his soup.

After Laime had killed the tarantula with a stick from the campfire, Enrique put aside his soup. He'd lost his appetite, and I didn't blame him. I made a mental note to stop wearing string sandals around the camp.

There was one more day's work for Perry, measuring angles from every conceivable spot in the canyon floor. It was ticklish business wading the swift Churun to get to the opposite side with his heavy theodolite and all the other necessary instruments.

Messages of congratulation came in on the morning broadcast time. We sent word to have the little airplane ready at the end

[illegible] airstrip within two days. More than ever I realized how valuable to the success of the expedition was the radio equipment, which could make such arrangements from as far away as this "lost world."

On Sunday, May 15, we were up [illegible] and ready for the trek out of the canyon. It was Lanie's birthday. While the Indians and Laime were breaking camp and packing everything in the backpacks, I dawdled on the plan I'd made the [illegible] before. I told Laime I was going on ahead alone. I explained [illegible] was so slow on the trail that this would give me a head start.

Alone in the Jungle

I left camp [illegible] thirty at 6, sure in the knowledge that the rest of the group would be along within a few minutes. The trail was not too difficult to follow, and the few times I did get lost for a moment I would simply make a small circle and find the blazed trees.

I [illegible] had been out more than half an hour, however, when the realization came to me in the jungle [illegible] on me with crushing force. The light drizzle or rain [illegible] wet leaves had reduced to the seen.

How [illegible] the jungle [illegible] when [illegible] no one else around! The sudden sounds and crackles, the momentary terror at passing a lair where animals have bedded down; the unmistakable odor. I wondered if the beasts were still watching me through the underbrush. I hesitated to go forward, and I didn't want to go back to join the group that must be somewhere behind.

I [illegible] in the [illegible] had [illegible] me to start out without a machete or [illegible] Finally [illegible] came after. Nothing visible moved except [illegible]

Laime and Enrique caught up with me a little after 8. We were determined to make the main camp in one day, but Laime was frankly gloomy at the prospects of my encumbrance on the long trip. Although impatient over the time that would be wasted, Laime agreed that we would take five minutes each hour for a rest period.

Little Simona Gets Her Pigtails Braided

While [illegible] Indians' hair was long and black, it was not [illegible]

The last few hours were sheer torture for me. I kept getting slower and slower. How [illegible] I could keep up [illegible] couldn't see. They would patiently wait for me at the [illegible] riverbank, about encouragement or point [illegible]

Somehow we made the main camp late in the afternoon. I have a dim memory of the last hours, the fording of the last stream, the last long to lug my waterlogged jungle boots through the [illegible] to climb over, and finally [illegible]

Fires Were Lighted Every Night To Dry Out the Travelers' Clothing

Here Patty Lowther, the survivor, [illegible] Mr. [illegible] from [illegible] of the [illegible] and [illegible] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Sno-Cats Mechanize Oregon Snow Survey

By Andrew H. Brown

Photographs by National Geographic Photographer Volkmar F. Kurz Jr.

"WATER [illegible] claimed R. A. Work, supervisor of Western States snow surveys. "And from the Rockies nearly to the Pacific most of our water comes from mountain snow."

Through the open windows of Work's office in Medford, Oregon, we gazed across miles of budding pear trees to the white crest of the Cascade Range. Birds sang and spooned in the warm sun. The date was March 18.

Yet next day we'd have to choke off spring fever and turn back our mental clocks to winter. We must pull on long underwear, thick socks, and wool shirts, and set out to buck those high-country snows at the season of their greatest depth.

We were going to try to travel in over-snow vehicles the length of the Oregon Cascades—the first journey of its kind.

Lean and limber R. A. (Arch) Work would be our leader. Arch is a senior irrigation engineer of the U. S. Department of Agriculture's Soil Conservation Service. His job is snow water, from cloud to consumer.

For four years Work had been using an ingenious track-ski-and-pontoon snow sled, the Tucker Sno-Cat, for snow-measuring jaunts into the mountains (page 690). On this long trip he planned to test the feasibility of further mechanizing snow-survey work. He hoped to prove that doing the job by Sno-Cat would be speedier and less costly than by ski and snowshoe.

Snow Waters Fields, Makes Power

Arch waved toward the frosted hills. "There'd be no fruit here in Rogue River Valley without that snow," he said. "Our rich orchards are all irrigated. It's the same story in hundreds of western valleys."

"Electricity, too," glancing at the light bulb over his desk, "would cost a lot more if snowmelt water from those peaks didn't spin turbines to give us 'juice' at fair cost."

Work explained that in eleven Mountain and Pacific States more than four-fifths of all the irrigation water flows from upland watersheds (page 706). In Utah, for instance, the 20 percent of the State's area above 7,000 feet elevation contributes from 70 to 80 percent of the total runoff. Most of the water is melted snow.

This situation makes [illegible] forecasting of stream flow [illegible] on measurements of the snow depth and water content.

In the yard outside Work's office men were piling sleeping bags, tools, and trunks of food into two orange Tucker Sno-Cats and their trailers. These were the rugged motorized sleds we counted on to haul our seven-man party the 500 plus miles from near the California border to the vicinity of the Columbia River (map, page 695).

Operation Sno-Cat Cascade was a joint project of the U. S. Soil Conservation Service and the Oregon Agricultural Experiment Station. Arch Work had invited the National Geographic Society to take part in what promised to be a spectacular journey. That's why Jack Fletcher, National Geographic photographer, and I were on hand at Medford.

"D Day" Arrives

Snow was falling as we rode to the jump-off point at Greensprings Summit. Daffodils and crocuses were blooming in valley dooryards, but up on the pass snow lay three feet deep.

Staff men of Medford's radio station, KYJC, recorded our departure. Then our two Sno-Cats chugged away up the forest path, pulling their heavy-laden trailers. Looking back, we could see cheery Hal Newhouse, the announcer, still chattering into his microphone.

Arch Work's smaller Sno-Cat led the way. With Arch rode photographer Jack Fletcher.

Jockey of the second Cat was Jasper Tucker, youngest son of the vehicle's inventor and builder, Emmitt Tucker. Jasper's Sno-Cat held five people comfortably. Beside Jasper sat Robert F. Beanstead, visual information specialist of the Soil Conservation Service. Bob was assistant director of the expedition and its skilled cook (page 699).

First Visitors in Ten Weeks

In the second seat Dr. Harvey Woods and Gaeton Sturdevant swayed with the Cat. Dr. Woods, from Ashland, Oregon, was medic for the journey. Gaeton Sturdevant, timberman, miner, pianist, engineer, and prospector, came as snow surveyor for the Oregon Experiment Station. I stretched out in the rear seat.

Our breakan run that first day took us

* See "Nature Sam's Rambles in Oregon," by Arvo Bryt, NATIONAL GEOGRAPHIC MAGAZINE, February, 1954.

Dressed as "Santa Claus Officials," Surveyors Enter a Snowshoe Field Cabin

[illegible]

With Cleats and Cleanse He Follows Snow's Course from Cloud to Consumer

[illegible]

60 miles through deep forest to Fish Lake. We [illegible] overnight at George Rowden's lodge. Snake-hipped George guards two irrigation reservoirs and measures two snow courses. He had been "outside" once recently on skis, but Glenna Rowden and 5-year old son Bucky were happy to [illegible] for a week.

Young Bucky told us of his pet bear [illegible] winter into the kitchen and begged at the bread box. Buck's father hauled the bear into Fish Lake on a [illegible] when he was one month old. They kept track of the infant's weight by hanging him by his skirt from the snow-sampling scale.

Great [illegible] were forced 200 feet above our vehicles as we wound along the road next morning beside Fish Lake on the Wood. The majesty, the utter silence and peace of the snow-muffled wilderness impressed us deeply.

Miles [illegible] of our whole route toward the Columbia River led through virgin [illegible] lands, most of them in national forests.

George [illegible], Lake of the Woods [illegible] part-time snow [illegible] served us sizzling-hot doughnuts [illegible] grease. He showed us the [illegible] end of the lake where his [illegible] the [illegible] and Lake Venice

Wilson's Stars Supercours on the Cascades Heads Next Summer's Irrigation Waters

were "at home." Ed guards 93 summer cabins. They were creaking under the burden of [illegible] almost continuous snowfall!

Ed [illegible] single climbed on skis to the ridgepole of one of the half-buried cabins as Jack snapped a picture. Just then Ed's wife called that coffee was ready. Ed nonchalantly skied down the steep roof. He wanted his coffee hot.

Lesson in Snow Surveying

At the Lake of the Woods snow course Jack and I took our first lesson in snow surveying. In the following weeks we all took turns at it.

"Snow surveyors," Arch explained, "are as fussy about placing snow courses as a garden clubber planting rare bulbs. We locate 'em above the level of winter melting, naturally, and preferably in forest clearings."

A steel pole topped with a yellow sign marked each end of the course. There were eleven stations (or sampling spots) at 100-foot intervals. Sampling stations average 10 to 15 to a course.

Gaston screwed together three hollow aluminum cylinders. When he drove the slotted tube through the snow to the ground, it showed the exact depth by inch lines on the side.

The tube picked up a core of snow. Using a small spring scale, Gaston compared the weight of the empty cylinder and the weight of tube-plus-snow. A simple conversion gave him the exact water content of the snow at each sampling spot (opposite page).

The standard kit contains six tube sections that permit gauging snow to a depth of 15 feet. In areas of heaviest fall 20 feet of tubing often is needed.

Gaston deftly juggled the tube in what I called the Ritual Dance of the Snow Surveyor.

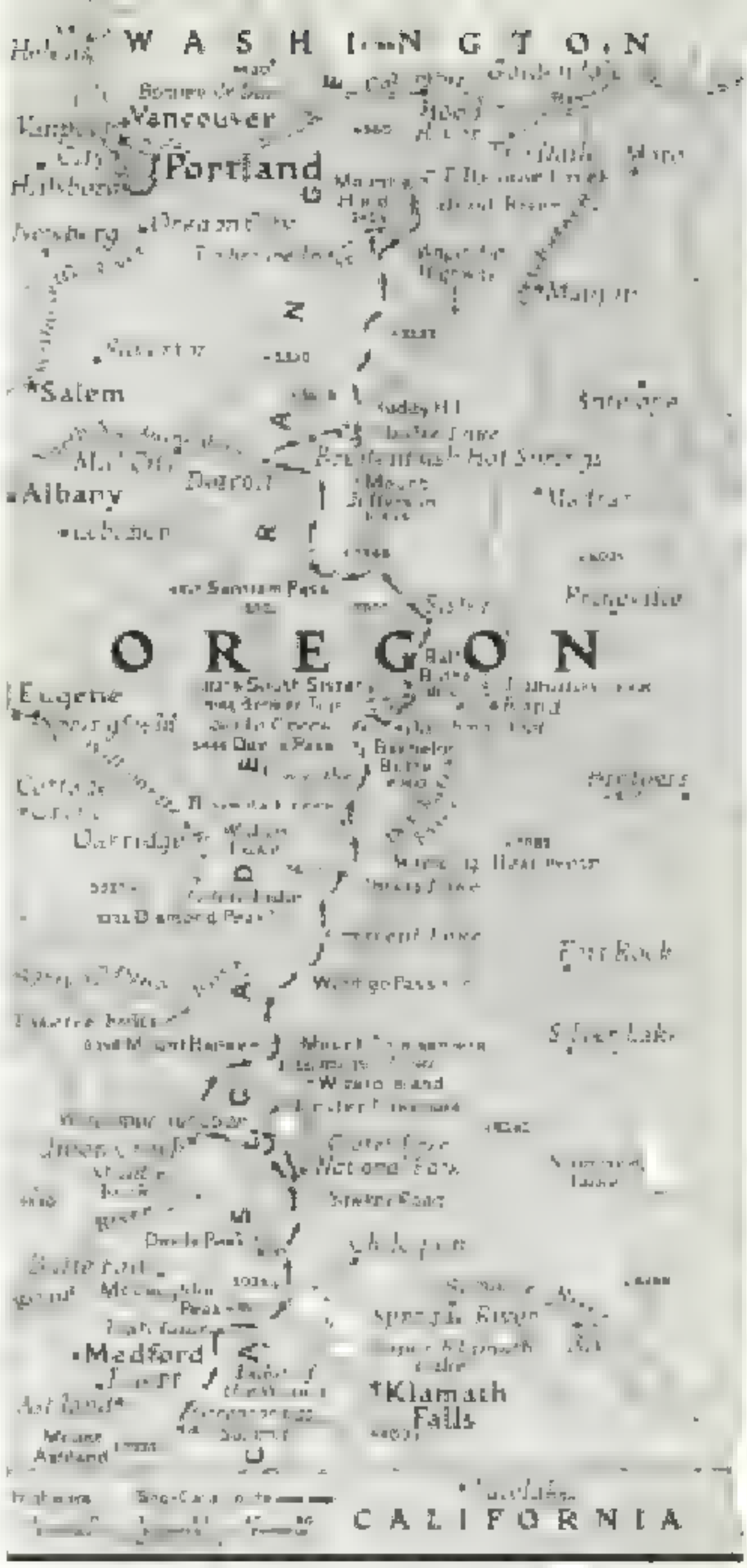
"Sample number seven: Snow depth four two point zero. Core three six point zero. Full weight three three point zero." Gaston called off the mystic numbers to recorder Bob Brainstead. "Water content one two point two five inches, ground frozen."

Reports Sent by Radio

We had a nightly short-wave radio schedule with W. T. (Jack) Frost, head of Oregon snow surveys, at his office in Medford (page 693). Each day's snow measurements were reported the same evening. Integrated with many other records, these figures gave the basis for the April 1 water runoff forecast for Oregon. That's the most important forecast of the year. By April, water users have to know how much of the priceless fluid will be available during the coming summer.

Furrowing our way among ruddy-barked ponderosa pines, we reached the south entrance road to Crater Lake National Park the next afternoon.

Men waved at us from a staff car and a truck. It was a welcoming group from park headquarters.



Snow Surveyors Traced a 573-mile Route Along the Spine of the Oregon Cascades

To test snowpackers for the work, Gaston Sun-Cat Cascade rambled south to north on the first complete ski mountain snow survey. Heavy spring blizzards slowed progress, later contributed to disaster on Columbia Valley floods (page 740). The party crossed Crater Lake National Park and skirted white cones of Mounts Jefferson and Hood, the latter Oregon's highest peak and heart of a popular skiing area.

New Wheeled Mount Dikeser, Deep, Soft Snow Prepares Abundant Water For Rogue River Orchards

[illegible]

Unable To Find a Cabin, Survivors Spend a Chilly Night under Canvas Stretched Between Snow Walls

[illegible]

Tokatee Falls Fed By Melting Snow, Thunders Down the Sheer Face of a Basalt Cliff

Evergreen Boughs Thrust Through the Snow Walls of Bob Branstead's "Kitchen"

[illegible]

[illegible] tendent [illegible] Parker [illegible] "I knew [illegible] at Bryce and Zion National Parks [illegible] when he was writing NATIONAL GEOGRAPHIC stories on those areas." Parker has since [illegible]

Forest and chief ranger Clyde Gilbert offered us helpings at the park base.

"We'd rather not drive up the plowed road," [illegible] Parker. "We'd choose to the top by the Hawkey Road. With the snow hidden it'll be three or four hours before we get there."

Not [illegible] we were [illegible] the Hawkey Road. In the interval we shoveled Snow by the ton flew [illegible] as we fought to keep the [illegible]

On street [illegible] they posted on their [illegible] When they [illegible] was [illegible] There was nothing [illegible]

When we were [illegible] rested [illegible]

[illegible] lacks just for fun. [illegible] farmer grew the right [illegible] the water [illegible] And [illegible] some Main Street lighted on Saturday [illegible]

[illegible] Parker [illegible] when we [illegible] we [illegible] [illegible] We [illegible] plowed [illegible]

[illegible]

Crater Lake Snow Piles 20 Feet Deep, Bringing Joy to Skiers and Water Consumers

[illegible]

and [illegible] [illegible] "International."

On [illegible] [illegible] at Crater Lake we [illegible] that a [illegible] had been [illegible] through [illegible]. The [illegible] [illegible] had [illegible] off with one of Jack's [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] into [illegible] [illegible].

On the Cone of an Ancient Volcano

We skirted the rim of Crater Lake [illegible]. [illegible] [illegible] [illegible] of cliff and [illegible], [illegible] [illegible] [illegible], [illegible] snow [illegible].

[illegible] [illegible] [illegible], we [illegible] down from the rim, [illegible] guide [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] of [illegible] Mount Mazama.

Our way [illegible] [illegible] [illegible] [illegible] we had to [illegible] [illegible] [illegible] [illegible] to [illegible] through. In summer these [illegible] are 20 feet [illegible] ground. [illegible] in the [illegible]ping snow was like wading through a ton of broken feathers.

[illegible] Jack [illegible] and [illegible] Woods were riding the front [illegible] of [illegible] [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]. As he [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible].

He stopped just in time. [illegible] the [illegible] [illegible] [illegible] Harvey [illegible] [illegible] [illegible] [illegible] [illegible]. In the [illegible] we [illegible] for a moment that Jack was missing.

[illegible] [illegible] [illegible] [illegible] we heard a muffled voice: "Here! [illegible] [illegible] here!"

[illegible] [illegible] Jack [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]. Jack [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

[illegible] [illegible] [illegible] and [illegible] [illegible] [illegible] [illegible] W. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

Helped by Shovelers, a SnowCat Struggles up Roads Hid in the Teeth of a Storm

[illegible]

[illegible] Sunshine Cheers the Party

[illegible]

[illegible]

[illegible] Rogue River [illegible] Rogue River [illegible] Rogue River [illegible] Rogue River [illegible]

[illegible] Mount Thielsen [illegible] Diamond Lake

West of this [illegible] 20 miles down the North Umpqua River [illegible] Lookout Point [illegible] Pacific Power Company [illegible] installation to help [illegible] Oregon's increasing power hunger.

[illegible] and general manager of the company, [illegible] a stirring [illegible] of engineering.

Wuxang Muses Spend Sat Searing Sees Of de Sonndilk over Snow and Ice

[illegible]

Easter Sunday began with warm, bright weather that packed the trail. We sped through chase-punked pine trees up switchbacks to Windigo Pass. There we crossed into the watershed of the Deschutes River. Water diverted from that stream irrigates grain and cattle country east of the Cascades.

At Crescent Lake, we reveled in the luxury of sheets and hot baths. Next day we rumbled on past Odell Lake to Oasis Lake. There a black jumbled lava flow looks as if it had cooled last week instead of two thousand years ago.

The Cascade Range is largely lava built. Forests and meadows cloak slopes and summits once seared by streams of liquid fire and pelted with ash and flying rock. "Pummy" (pumice) desert and slaglike lava flows testify to volcanic activity that once raged from California to the Canadian border.

In porous volcanic formations water does strange things. Brimful rivers shrink in a few miles to shallow trickles. Contrariwise, clear cold streams burst full-volumed from the ground in bubbling springs.

We passed Wickiup Reservoir, a man-made lake. It lost, we learned, 1,000 acre-feet of water a day through seaplike lava banks that seemed sound when the dam was built. Major leaks have since been plugged.

The night of March 29 we made early camp in a holiday mood at Browns Creek cabin, the halfway mark on our route. Bob was frying steaks when visitors appeared, rolling up to the door in an ex-Army weasel.

"Why, you ornery ole polecat, you!" Arch greeted long-time friend Bill Childreth. With him rode Bill Dean. They'd been measuring stream flow and a snow course at isolated Waldo Lake.

After supper Bill Childreth and Arch fell to yarning about shared adventures.

"Remember, Arch, that trip we were *really* tired?" Bill asked.

Arch grinned and nodded.

"Arch and I'd had a rugged day, pretty close to 25 miles on skis," Bill recalled. "We found our cabin late, grabbed a bite, and tumbled into our sleeping bags like steers felled with a club.

Robbed by Father Time

"Later I woke. It was just dim dawn, so I rolled over for a few minutes more. A while later I cracked an eye again. It seemed darker. Well, I thought, clouds must've come up. Finally we both woke. Bright morning sunshine was a-beamin' down.

"When we got to town that afternoon, we noticed a calendar in a store window. It said 'February 8.' We just looked at each other. I knew we'd measured the snow course on the 6th.

"Suddenly the truth struck us. That 'dawn light I'd seen was sunset light! Arch and I had slept through a whole day."

Just out of Browns Creek the nut locking the left pontoon to the axle on Arch's Cat dropped off. This mishap cost us a day, the only serious mechanical delay on the trip. Arch and Jasper had to go 50 miles northeast to Bend to have the axle repaired.

Gleaming Summits Pierce the Sky

All April Fools Day splendid scenery flowed past us in a glorious panorama. We pushed up into the heart of great mountains: the broad cone of Bachelor Butte, the steep peak of South Sister, and jumbled crags of Broken Top. Gleaming summits lifted high above tree line.

We circled Elk Lake, a perfect Christmas card scene complete with snowy pines and half buried cabins. At Devils Pass we clawed up a steep snow gully under beetling black cliffs. Huge boulders seemed ready to plunge down on us at a touch.

At our Soda Creek camp snow was too deep to dig through. Arch laid green logs and built the fire on them. Even so, by morning the fire and hot coals had melted a round hole eight feet deep.

Log fires at our sky camps warmed us and dried our wet clothing. Bob cooked on two gasoline stoves, with a total of five burners (page 699). Wood fires also helped with melting snow. At several camps there was no open stream or pond. We had to melt snow, a slow and exasperating procedure, not only to get water for dishwashing but even to fill canteens.

It was ironical to be almost buried in frozen water—and not be able to spare enough of the precious melted liquid to brush our teeth!

Friday, April 2, we pushed dizzily up, up, and up among peaks and clouds that fought back with blinding snow and moaning winds. Ten minutes out of Soda Creek, Arch stopped his Cat on a steep side hill. Like a combat commander, he swept his arm forward over his head in a familiar gesture. It meant, "Send up one wave of shovelers!"

Late that afternoon, after measuring the Butchman Flat snow course, we smacked into a bit of going as vicious as anything we hit.

Twisting around the base of Bull Butte Jasper twirled the stiff steering wheel until sweat beaded his brow. We seesawed along,

"First Come, First Served" Is the Rule in Winter S[illegible]

[illegible] Rogue River Valley [illegible]

"You'd think [illegible] of Winter [illegible] was throwing [illegible] of white [illegible] at [illegible] exclaimed. "If it wasn't so darned cold!"

We [illegible] and snowy [illegible] in the snow. Anything but [illegible]. With [illegible] we [illegible] and windbreak [illegible] weighted with snow blocks. The windbreak kept the drifting snow from burying us, but also [illegible] the door [illegible] to sleep. [illegible] we were [illegible] out into the [illegible] of [illegible].

Bob cheerfully [illegible] the elements with a [illegible] of pea soup [illegible] corn [illegible] coffee [illegible] and [illegible] was [illegible] with Medford.

We heard [illegible] [illegible] the air.

[illegible] calling K-K-K-K [illegible] Medford. Come in [illegible] K-K-K-K [illegible] [illegible] calling K[illegible].

Then [illegible] we heard [illegible] [illegible] and [illegible].

[illegible] Kay, Kitty, [illegible] well [illegible].

[illegible] He did a wonderful job [illegible] was an eighth member of the [illegible] our progress.

[illegible] eating our [illegible] [illegible] down [illegible] We were riding a roller coaster with [illegible] wheels.

I recall [illegible] a couple of [illegible] [illegible] their [illegible] on the [illegible] of the [illegible].

Blizzard "Helps" To Make Camp

Our [illegible] camp on March 22, below Ball [illegible] [illegible] [illegible] about 1[illegible] feet [illegible].

"[illegible] go, you [illegible]!" [illegible]

up." Arch's [illegible] [illegible] reminded us of [illegible] [illegible] [illegible].

[illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] Jasper was [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

[illegible] [illegible] [illegible] Jack. [illegible] [illegible] [illegible] [illegible] [illegible].

[illegible] [illegible] [illegible] [illegible] and [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

The [illegible] [illegible] to get out of [illegible] the Sno-Cats [illegible] [illegible], plunging down to [illegible] Creek through [illegible] hemlocks. [illegible] [illegible] [illegible] [illegible] with snow [illegible] [illegible] [illegible] [illegible] [illegible] Western [illegible] and [illegible].

From the [illegible] of [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] to the little [illegible] town of Detroit. Now we were on the west slope of the Cascades, on the gathering ground of the North Santiam and other streams that feed the Willamette River, trunk stream of one of America's richest agricultural valleys.

An Expert on Water for Others, He Uses It Sparingly Himself

Bob [illegible] fills a canteen from a stream near Upper Klamath Lake. The party often went without water for [illegible] [illegible] [illegible] [illegible] it over a fire was usually a slow, exasperating process [illegible].

Turning back [illegible] [illegible] [illegible] we [illegible] the night of April 5 at [illegible] Hot Springs. [illegible] [illegible] [illegible] [illegible] [illegible] snow was well packed and the trail smooth and easy to [illegible].

Arch Has a Narrow Squeak

[illegible] are [illegible] [illegible] [illegible]. Arch and Jack had a close call with the lead Cat. [illegible] crossed a [illegible] buried bridge over a [illegible] creek. Sculptured by wind, snow had [illegible] [illegible] [illegible] [illegible] of the bridge [illegible] [illegible] [illegible] [illegible].

Half the snow [illegible] [illegible] [illegible] Arch's [illegible] [illegible] [illegible] [illegible] as [illegible] [illegible] Jack [illegible] [illegible] [illegible] black [illegible].

Arch didn't talk [illegible] [illegible] the [illegible] cornices, hazardous [illegible] of snow work. [illegible] danger [illegible] the [illegible] [illegible] of snow surveyors [illegible] [illegible] [illegible] [illegible] [illegible] and then. [illegible] [illegible] [illegible] Arch [illegible] [illegible] [illegible].

[illegible] [illegible] [illegible] [illegible] Peak, at the head of the [illegible] of the Rogue River. He [illegible] [illegible] [illegible] into the snow, one on each side of [illegible], then went out on a snowy shelf to take motion [illegible] [illegible] [illegible] [illegible].

When he turned back to pick up his ski

Giant Reservoirs, Like Eastern Oregon's Owyhee, Store "Snowpack" Water To Irrigate Once-Desert Farmlands

Swift Waters of Hell Creek, Kicking Through Deep Snow, Carve Tiny Islands Like Frosted Cakes

[illegible]

poles, one of them was gone. Where it had been was a round hole. Arch peered down this window in the snow floor—and saw Cliff Lake a thousand feet almost straight down! He swallowed hard and trod mighty gently back to solid rock.

All unsuspecting, he'd casually walked out on a thin snow cornice overhanging a sheer drop nearly as high as the Empire State Building. Later, Arch showed us a movie sequence of the forest far below taken right through the hole!

Up the icy slope of Ruddy Hill we dug a 1,000-foot ditch for the Cats, blasted the while by hard, stinging snow (page 701). We measured the Olallie Lake snow course and reached the Forest Service guard station at the north end of the lake as the storm quit. Sunset gilded the forest.

That was our last night away from civilization. We feasted on thick steaks and fed huge logs into the fireplace. After supper, lusty voices lifted in loud but tortured harmony. Some prankster stuffed shoes, chunks of wood, empty jars, and wet socks into our sleeping bags.

Sunrise came calm and clear on April 7. To the south mighty Mount Jefferson doffed a cloud cap from its 10,495-foot cone. Framed by pines, the white frozen lake, and blue sky Jefferson symbolized the beauty and splendor of this wild country.

Bob Thomlinson, special events commentator of Portland's radio station KGW, was at the Wapinitia Highway crossing to greet us as we approached Mount Hood.

"We've been here a few minutes," he said. "We had estimated our scheduled arrival time by radio the night before!" "We knew Arch Work would make it on time."

I caught Arch covering a wry smile with his hand. By our original itinerary we were six days late a nearly!

In the luxury of Timberline Lodge on Mount Hood we relaxed for a day. Up from Portland to visit with us came N. J. Penick, forest supervisor of the Mount Hood National Forest; L. G. Jolley, assistant supervisor; ranger J. P. Langdon; and fire guard James J. Ralph. With them was Bob Henderson, assistant to the director of the Oregon Experiment Station. Bob finished the trip with us.

Ranger Defines a Rabid Skier

Mount Hood is the West's most popular ski resort for the area explored. The Forest Service and the Ski Patrol find lost skiers and hand casualties to the doctor.

District ranger Langdon defined a rabid skier for us: "We heard that a skier was helpless up on the peak with a leg fracture. When we got to him, we found him suffering no pain. It was his wooden leg he'd broken!"

Mr. Penick told us of the Forest Service's interest in snow surveys: "The Forest Service attitude toward the forest has changed. We used to be housekeepers of the woods, protecting the trees, regulating cutting, and supervising recreation. In a way, we couldn't see the forest for the trees.

"Now we have a new interest—a vital concern with the water crop the forest holds. We know that the money and welfare value of the snow-melt water grows year by year.

"The snow pack in the forest affects our plans for fire control. It affects stream flow and lake and reservoir levels, of crucial importance to farmers. Sport fishermen also have a stake in water stored on the peaks as snow.

"You'll find every western national forest shares our concern with the high-country snow pack."

Crag Rats Meet Sno-Cats

Friday, April 9, was our last day on the trail. An easy run led us around the east side of Mount Hood to Tilly Jane Creek. Below us lay the fruitful Hood River Valley and the Columbia River gorge.

Our sturdy, long-suffering Tucker Sno-Cats ground to a halt. On hand to greet us were members of Hood River's climbing club, the Crag Rats. Despite dire predictions, cordiality marked the encounter of Sno-Cats and Crag Rats.

We seven members of Operation Sno-Cat Cascade looked, I'm sure, as smug as fishermen with full creels. It was a fine feeling to be standing at our goal.

The faithful Cats had ticked off 573 speedometer miles. We had crossed the main divide of the Oregon Cascades 15 times. We had measured 13 snow courses. We were behind schedule for a reason that brought joy to water users. It had snowed on 20 of the 27 days we were on the trail.

This glee was tempered later, in May and June, when runoff from the heavy spring snows devastated parts of the Columbia Valley with record floods.

We never really "had it tough." Arch Work had planned the expedition with utmost care. We always had three essentials to the success of a hard trip—dry bedding, plentiful food, and adequate shelter.

Doc Woods saw to it that we stayed healthy. The only ailments suffered were scratched hands, sore muscles, and blisters from the spluttering tar-and-paraffin we

Jack Frost's Popsicles Make Up in Size What They Lack in Flavor

[illegible]

heated to wax the Sno-Cat [illegible]. We [illegible] a [illegible] to Bob [illegible] [illegible] with [illegible] for [illegible] purposes.

"What do you think now, Arch, about the usefulness of mechanizing snow surveys?" I put the question to Work as we neared a Grand [illegible] in Portland that night.

"Well, Andy," came the considered answer, "[illegible] but [illegible] snow surveying is here to stay on two top, the way I see it [illegible] one point and disproved another.

Sno-Cats Can Streamline Surveying

"[illegible] will greatly [illegible] and speed up trips from the valleys to the mountain snow courses. But I don't think it'll be good sense to [illegible] all our snow courses in the [illegible] order [illegible]. You saw how easy [illegible]."

"How do you think the best use can be made of courses, [illegible] in snow surveying?" I asked.

"Here's the way to do it," Arch promptly replied. "Putting the Sno-Cat on a truck, two men [illegible] to the [illegible] of the [illegible]. [illegible] the Cat, [illegible] one, two, or three [illegible] snow courses, measure them, [illegible] the truck again [illegible] the next day.

"[illegible] the process, measuring maybe 30 snow courses in [illegible]. Think of the [illegible]!"

In [illegible] with Arch to Reno, Nevada, to attend the 1948 Western Snow Conference. This congress [illegible] the [illegible] in all the Western States.

There we [illegible] of the large picture into which [illegible] a puzzle [illegible] which [illegible] was [illegible].

[illegible] we [illegible] State, Federal, [illegible] the [illegible] snow crop [illegible]. Here was a [illegible] example of

mutual assistance, even cutting, sometimes, across barriers of divergent interests.

Able men from all over the West came together to pool their intimate knowledge of mountain snow. They served the various interests of the whole population of the rich but semiarid Western States.

Discussions crystallized for us the reason for-being of snow surveys and runoff forecasts. It was as clear, if not as simple, as ABC. We learned that:

When farmers can be forewarned of drought, they plant only such crops as can be brought to maturity with reduced water supply. "Outwit the drought" has become a slogan.

They prune, thin, and cultivate their orchards so that they will produce only as much fruit as available irrigation water will bring to marketable size and condition.

They move livestock off the ranges and out of drought-stricken areas before they starve. And they develop wells, storage ponds, and other supplementary water supplies before the situation grows acute.

In years of abundant water supply, on the other hand, farmers can bank extra cash made as profit on added acreage brought under cultivation. Surplus water means "bonus" crops.

At the Reno conference we learned that the water requirement of alfalfa, grain, pasture, orchard, or other irrigated crops for a given soil type can be precisely stated. All this planning saves time, seed, labor, and money. Best of all, it largely eliminates the possibility of total crop failure.

Snow surveys are important, too, in giving advance warning to help in confining flood destruction.

A sentence like "Snowflakes sift down thick and soft to the silent forest floor," summons up a picture of quiet peace and hushed beauty.

Yet what an unruly giant may be unleashed when spring sun and rains melt drifts piled deep on mountain slopes! Rivulets gurgle under the sodden snow. Great rivers roar on swirling rampage.

Snow Melt Boosts Columbia Flood

That's just what happened in the snow-burdened Columbia River Basin in the spring of 1948. Warm weather and continuous rain made raging sluiceways of every mountain valley.

The 45-day Columbia flood ran up a heavy toll: Vanport City shattered, with many drowned, a $25,807,300 loss to agriculture in crops and cattle destroyed in the field, approximately 224,000 acres of farm and grazing land inundated; homeless estimated at 30,000; total losses in agricultural resources alone estimated at $370,307,300.

Early summer floods on many western rivers are due almost entirely to melting snows. The magnitude and time of each flood is, therefore, approximately predictable on the basis of snow surveys.

Pioneer of snow surveying in the West was Dr. J. E. Church of the University of Nevada. In 1912 Dr. Church began measuring the depth and water content of Sierra Nevada snows, whose melting affected the level of Lake Tahoe.

For a decade private companies in California, Wyoming, and Washington made scattered snow surveys. In 1924 Utah started to study the relationship between snow cover and runoff. Five years later Oregon and California were operating State surveys.

Federal Government Backs Snow Surveys

Methods and equipment, however, still were not standardized, nor was there yet free exchange of information.

At last, in 1935, Congress charged the U. S. Department of Agriculture's Division of Irrigation with the task of coordinating and extending the snow-survey program. The work was transferred to the Soil Conservation Service in 1939.

Today almost a thousand snow courses at elevations from 2,000 to 12,000 feet are measured in 12 Western States—California, Oregon, Washington, Arizona, New Mexico, Utah, Nevada, Colorado, Wyoming, South Dakota, Montana, and Idaho—and in British Columbia, Canada.

Nine hundred and forty-one snow surveyors, traveling 30,150 miles in 1948 by ski, snowshoe, or mechanized vehicle, made 40,014 individual snow measurements.

Snow-surveying and water forecast work in the West is estimated to cost less than a cent for each acre of irrigated land. The West has 21 million irrigated acres!

This is how Arch Work summed up the new hold that snow, as stored water, has on western thinking.

"People in the West," he said, "now recognize that snow is a vital basic resource. They've come to realize it must be measured, conserved, and 'harvested' as carefully as soil, forests, bird, and fish.

"They know that water means life to the West."*

* See, in the NATIONAL GEOGRAPHIC MAGAZINE: "More Water for California's Great Central Valley," by Frederick Simpich, November, 1946, and "Columbia (River) Turns on the Power," by Maynard Owen Williams, June 1941.

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In addition to the editorial and photographic surveys [illegible] of field work to achieve these [illegible]

The Society's notable expeditions have pushed back the historic horizons of the [illegible] By dating the ruins of the vast communal dwellings in that region, The Society's [illegible] three hundred years.

[illegible] discovered [illegible] in the Americas for which we have [illegible] stone is engraved in Mayan characters [illegible] means November 4, 291 B. C. (Spinden Correlation). It antedates by 200 years anything heretofore dated in America, and reveals a great center of early American [illegible]

On November 11, 1935, [illegible] ascended to the world altitude record of [illegible] Capt. Albert W. Stevens and Capt. Orvil A. Anderson took aloft in the gondola nearly a ton of scientific instruments, and obtained results of extraordinary value.

The National Geographic Society–U. S. Army Air Forces Expedition, from a camp in southern Brazil, photographed and observed the solar eclipse of 1947. This was the seventh expedition of The Society to observe a total eclipse of the sun.

The Society cooperated with Dr. William Beebe in deep-sea explorations off Bermuda, during which a world record depth of 3,028 feet was attained.

The Society granted $25,000 and [illegible] when the Congress [illegible] appropriation for the [illegible] was insufficient, and the finest of the giant [illegible] in the Giant Forest of Sequoia National Park of [illegible] were thereby saved for the American people.

[illegible] outside the [illegible] Alaska [illegible]

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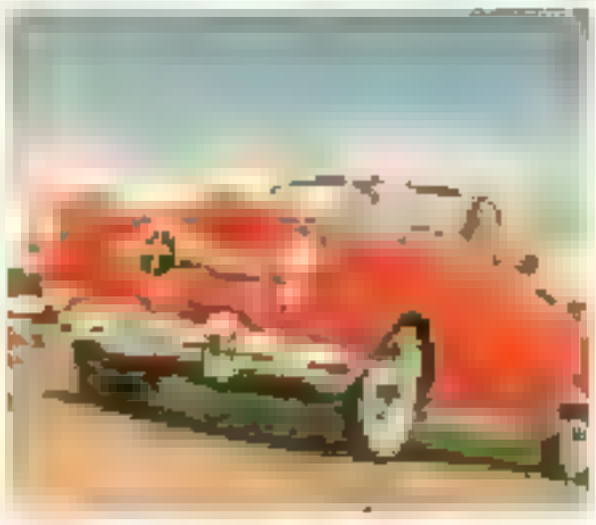

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Secretaries have a [illegible] Top O' The Morning [illegible] when they use the TIME-MASTER [illegible] and the *Mersdorf's* clarity have changed [illegible] psychology about dictating machines. [illegible] like to get work done faster and with less [illegible]

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Bing, like everybody else, [illegible] drum so small you can mail 3 of them in an [illegible] binary envelope.

[illegible]

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[illegible]

[illegible]

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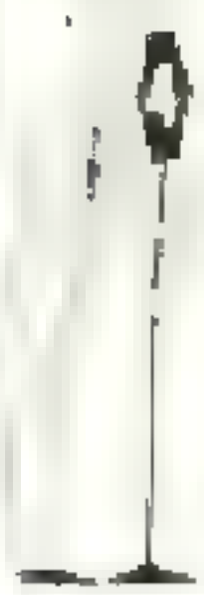
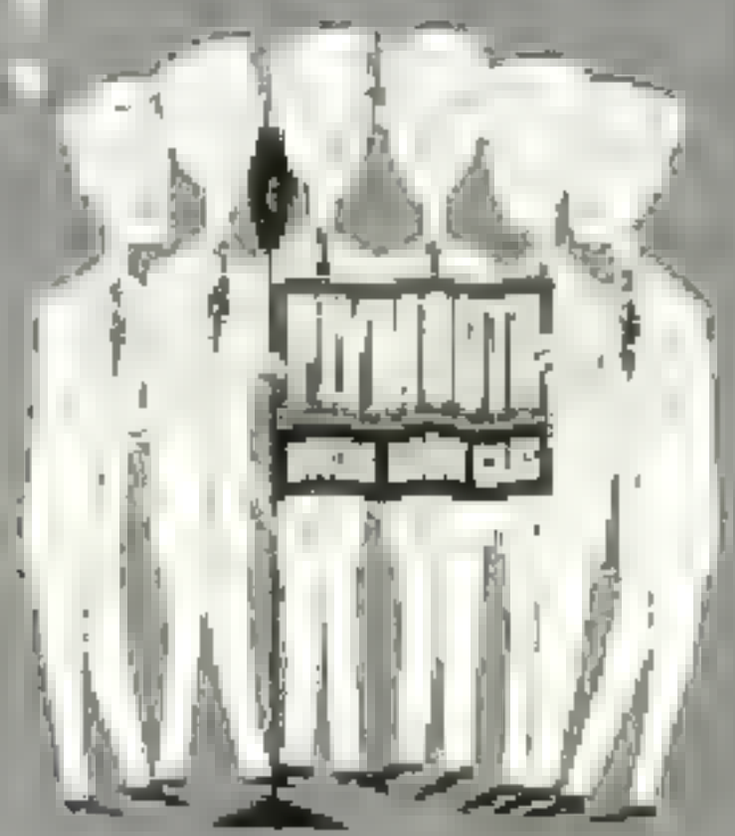


4. Which car has Air-Flit Ignition Starting for your greater convenience?

5. Which car has Floating Power for smoother engine performance and longer car life?

6. Which car has Automatic Electric Choke for quicker warm-up, more economical use of gas?

You said it! THE ANSWERS ARE ALL THE SAME – **PLYMOUTH**



the car that likes to be compared

[illegible]

Quick change artist

[illegible]

Prolonged research [illegible] has [illegible] for the first time in [illegible] years of phonograph history—a record and automatic player designed for each other.

[illegible]

[illegible] seconds.

Remarkable, too, are the new records [illegible] playing time [illegible] these compact [illegible] plastic [illegible]

[illegible]

[illegible]

[illegible]

* * *

[illegible]

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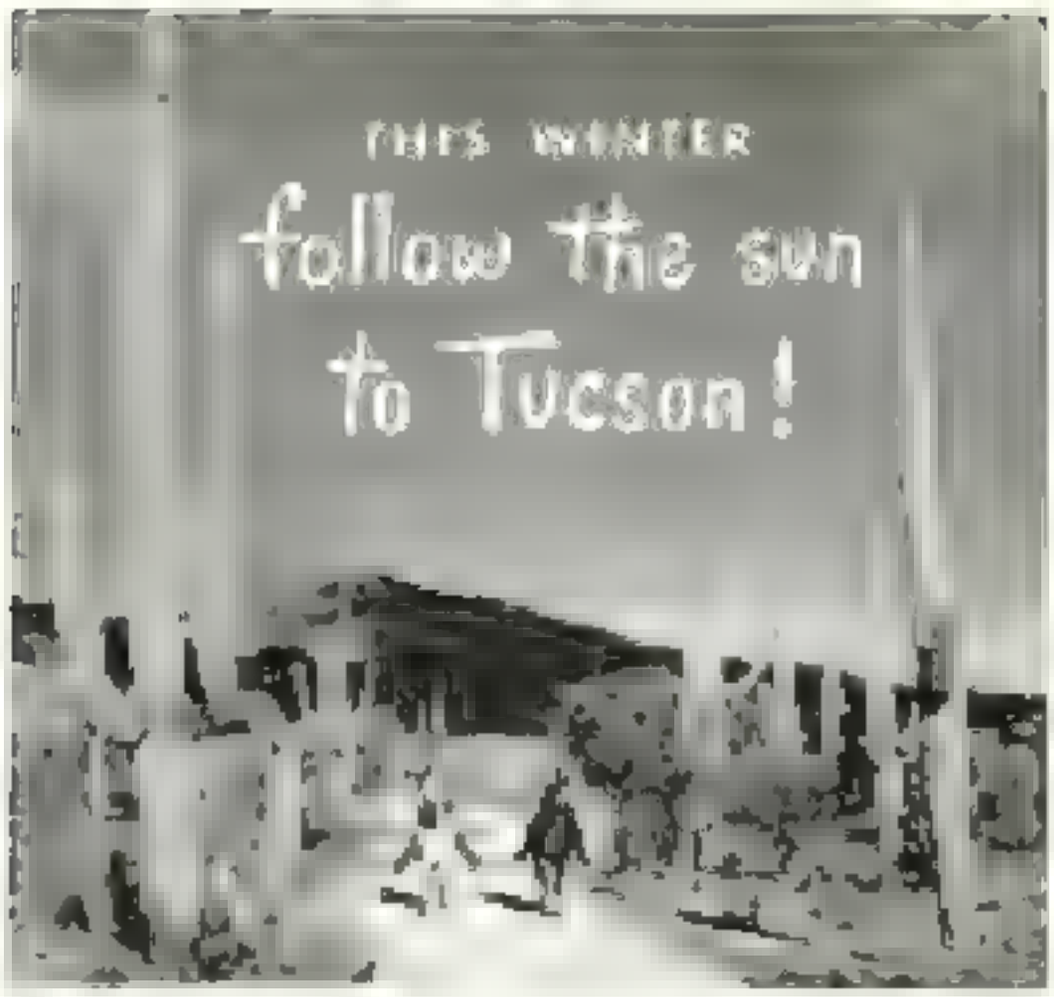

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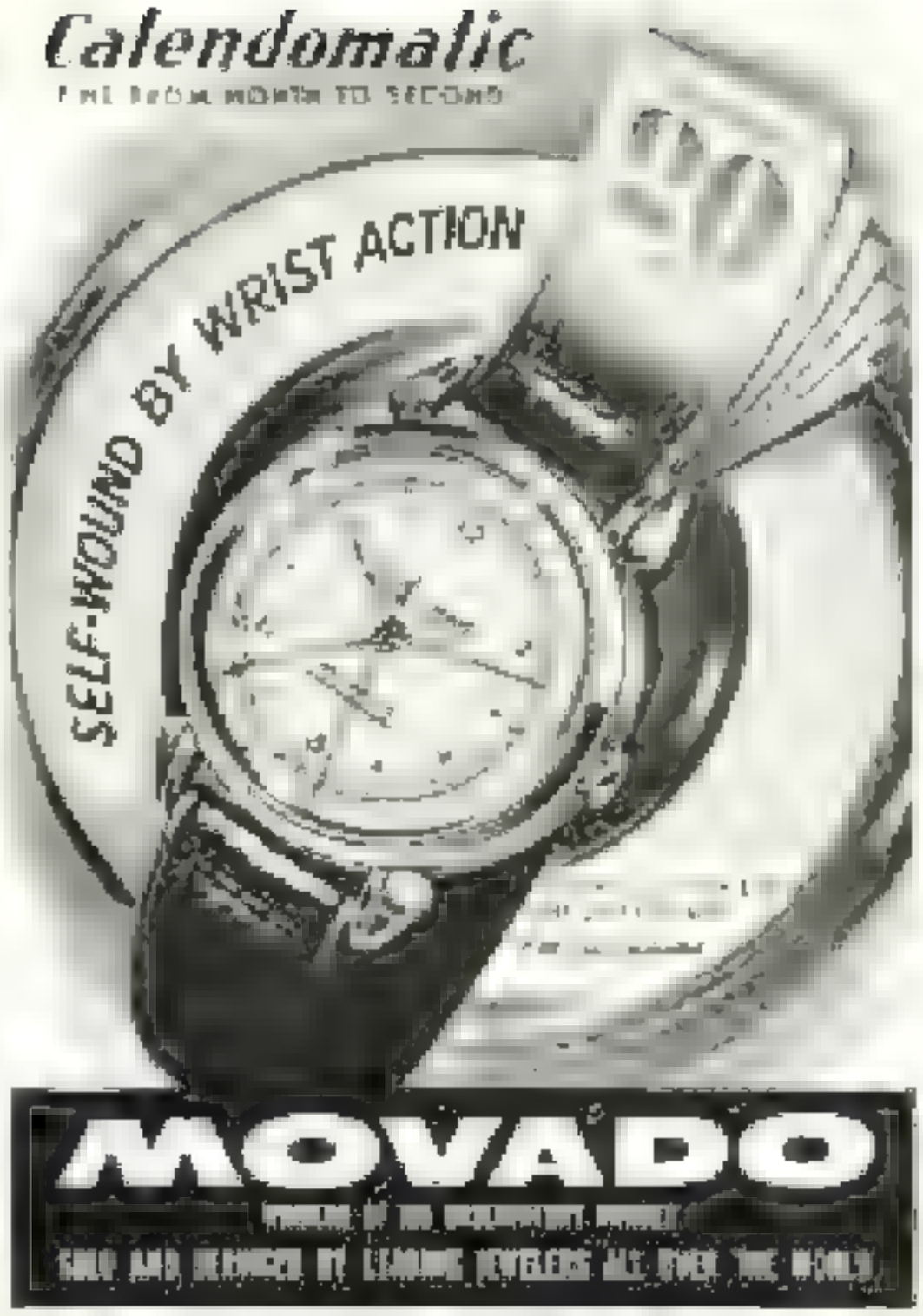

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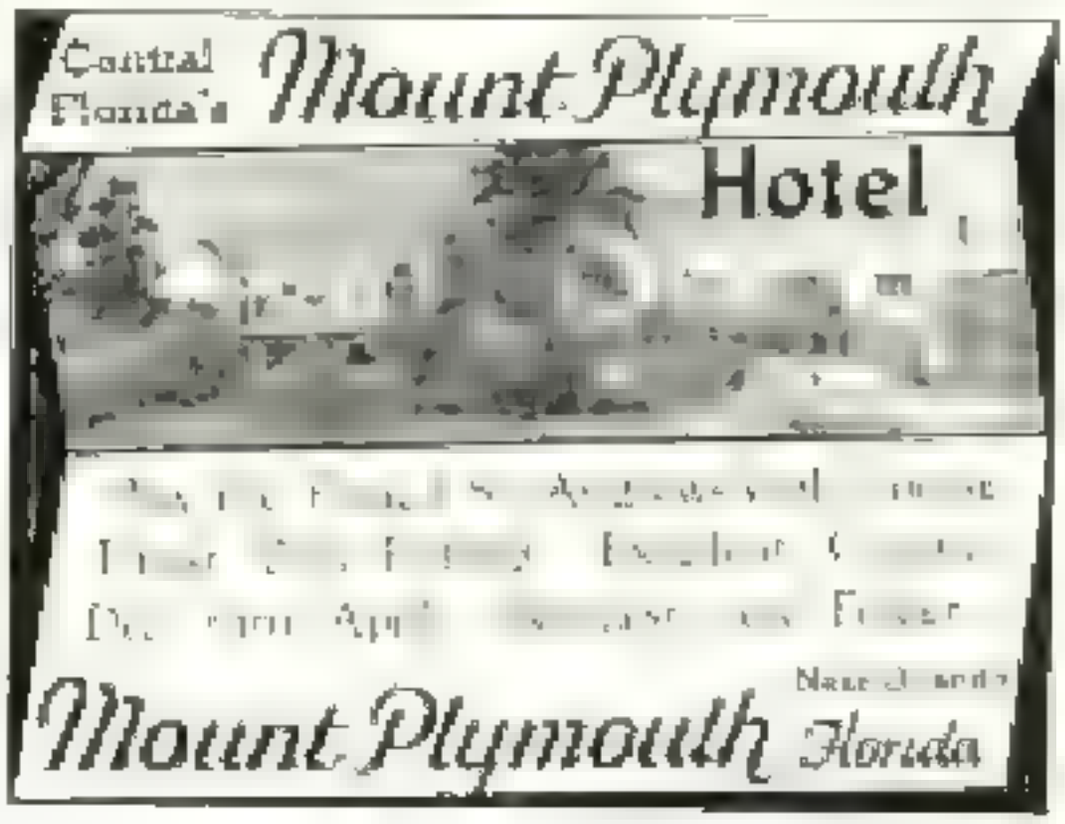

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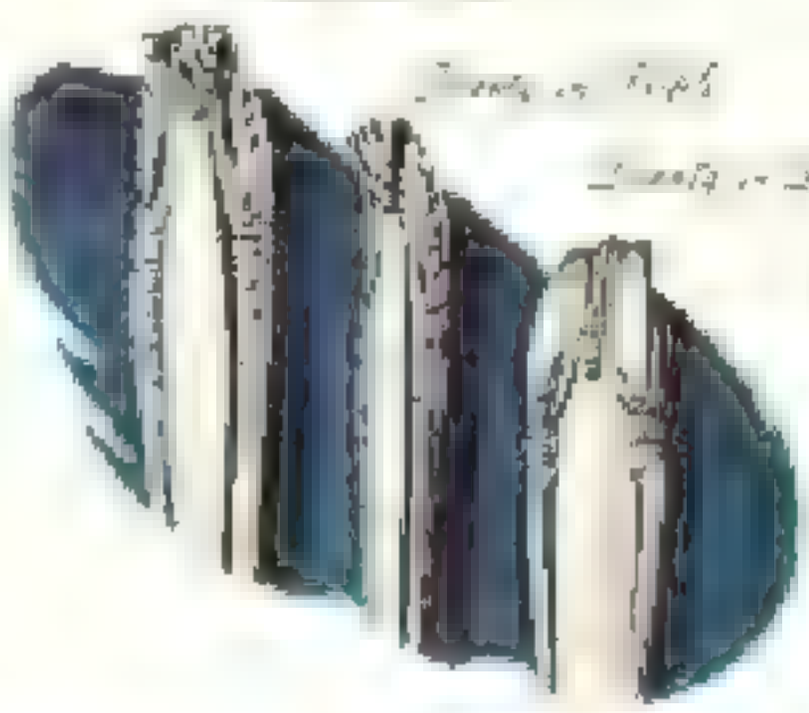

WALLACE
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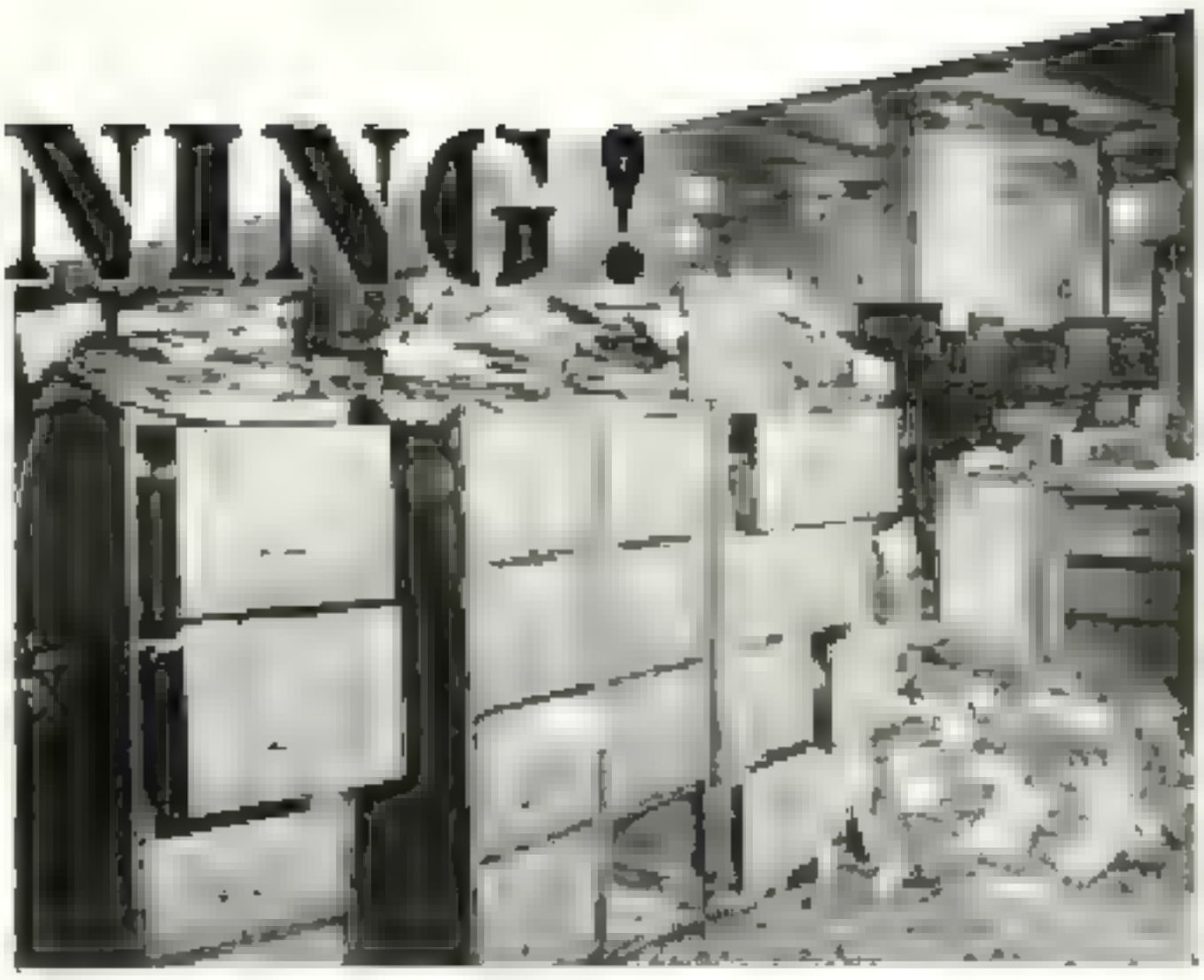
Silver

WARNING!

You're throwing your business in an incinerator...



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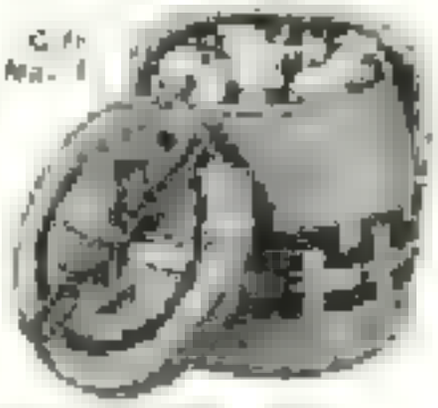

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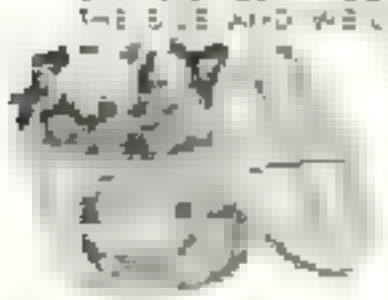

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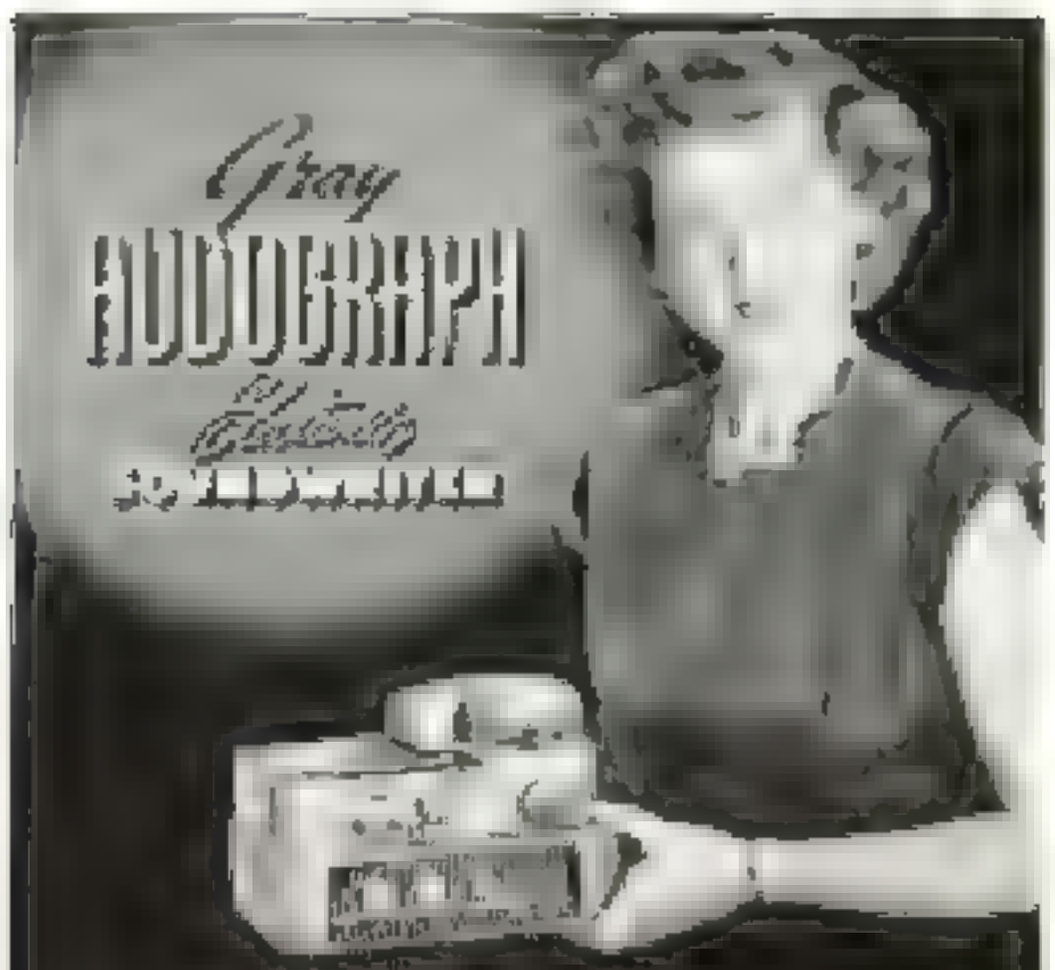
The professional and technical services you receive.

Your own special seeing problem.

The quality and style of glasses your prescription calls for.

When your vision fails [illegible] be aid of professional and technical services. [illegible] Services provided by Ophthalmologists, Optometrists, Ophthalmic Dispensers (Opticians) are widely available and within the reach of all. They are worth [illegible]

American Optical



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Please send me your free booklet of Winter Resort and Ranch Vacations.

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GOOD DIGESTION

_ a foundation for good health

THE DIGESTIVE SYSTEM has been called "nature's most wonderful chemical laboratory." Throughout life, the vitality and strength of every part of the body depend largely upon how well this laboratory does its work.

Sometimes, however, the digestive processes fail to function properly. This may be due to faulty eating habits, infections, fatigue, food allergies, emotional disturbances and other causes and may lead to minor as well as serious digestive disorders. In fact, studies show that digestive troubles are more common than any other ailments except those of the respiratory system.

1. Avoid eating when rushed or when emotionally upset.
2. Keep the teeth in good condition so that food may be chewed thoroughly.
3. Drink adequate amounts of water (six to eight glasses a day) and establish a regular habit of evacuation.
4. Do not eat too much or too often.
5. Cultivate an appetite for a wide variety of foods, especially those that are rich in the essential nutritional elements.
6. Avoid strenuous exercise immediately after eating.
7. Do not resort to self-treatment. If digestive complaints persist, consult the doctor.

Modern medicine has developed many instruments and tests which help the doctor to diagnose digestive disorders with great accuracy. For instance, X-rays permit the doctor to follow "test meals" throughout the digestive tract and to observe the position, size, shape, and movements of the digestive tract. In addition, chemical tests and analyses give him essential information about whether the digestive organs are functioning properly.

Some digestive conditions are so trivial that they can often be corrected by surprisingly simple measures, such as eliminating irritant or irritating foods from the diet. Others are serious and, if allowed to progress, may affect general health, and require prolonged dietary restrictions or surgery.

So it is always wise to seek medical advice for persistent digestive complaints such as pain, nausea, "indigestion," or even continued lack of appetite. The doctor, in most cases, can quickly discover the causes and suggest corrective treatment that may help to insure better digestion and better health.

His ears give Dipodomys a head start

THE TARDIGRADE KANGAROO RAT, *Dipodomys agilis*, lives in an underground house built for [illegible] predators.

[illegible] tunnels and [illegible] chambers. And there are many exits, so if a [illegible] Dipodomys can reach it in a flash—should a coyote, or other predator, be sleeping for [illegible]

[illegible] of his front hair, he does not [illegible]

[illegible] but before he loses the head start his remarkable reflexes give him

[illegible] has many [illegible] to protect by nature to duck trouble. But in dealing with misfortune, man has gone [illegible] better. For man [illegible] out of the way of trouble [illegible] through insurance, for losses [illegible]

[illegible] misfortunes may entail. Think of the

If you're hurt, a [illegible] will help you [illegible] your expenses [illegible] And [illegible] make sure that those who depend [illegible] will have an income no matter what happens to you.

If thieves break in, burglary insurance will reimburse you for the loss they cause, the damage they [illegible]

To make sure you have enough of these and the other kinds of insurance you need, call on your Travelers agent or broker.

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1. [illegible]

What to look for in a watch . . .

2. [illegible]

3. [illegible]

4. [illegible]

5. [illegible]

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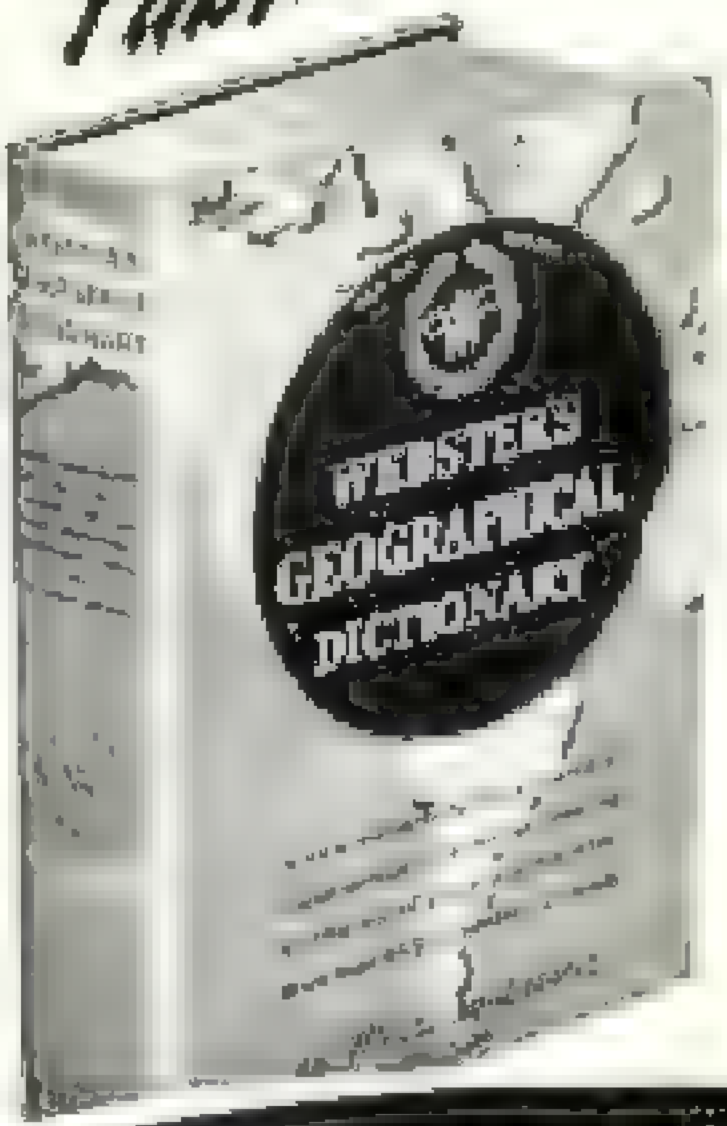

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